J. T. Altman M.
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268

THE

PRACTICE OF OBSTETRICS

BY

AMERICAN AUTHORS.

EDITED BY

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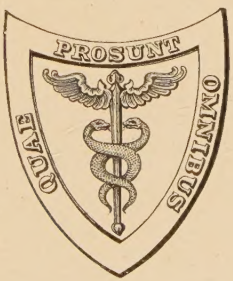
THIRD EDITION, REVISED AND ENLARGED.

ILLUSTRATED WITH 484 ENGRAVINGS, 46 OF WHICH ARE IN COLORS, AND 36 COLORED PLATES.



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PREFACE TO THE THIRD EDITION.

The aim in this work from its inception has been to present clearly and concisely the principles and practice of obstetrics in accordance with a simple and rational plan suited alike to the needs of student and practitioner. In the present edition extensive revisions have been made, and some new matter, together with many new illustrations, has been added. Several subjects have been wholly rewritten. Among these are the Changes in the Maternal Organism Caused by Pregnancy, the Duration of Pregnancy, the Hygiene and Management of Pregnancy, the Anomalies and Diseases of the Fœtal Appendages and the Diseases of Pregnancy, all contributed by Dr. W. S. Stone. The article on Malformations, Injuries and Diseases of the New-born Child was prepared by Dr. E. H. Bartley. The section on Symphysiotomy has been condensed and a brief account introduced of Hebotomy and of Vaginal Cæsarean Section.

Acknowledgment is due to the Contributors for their valued coöperation in the work, to Dr. W. P. Pool for the preparation of the index, and to the Publishers for their uniform courtesy and liberality.

C. J.

Brooklyn, N. Y., 1907.

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CONTENTS.

PART I.

ANATOMY.

CHAPTER I.

PAGE

THE FEMALE PELVIC ORGANS—THE MAMMARY GLANDS 17
By ALGERNON T. BRISTOW, M. D.

PART II.

PHYSIOLOGY OF PREGNANCY.

CHAPTER II.

MENSTRUATION—OVULATION—DEVELOPMENT OF THE OVUM 71
By WALTER P. MANTON, M.D.

CHAPTER III.

CHANGES IN THE MATERNAL ORGANISM CAUSED BY PREGNANCY . . 118
By WILLIAM S. STONE, M. D.

CHAPTER IV.

DIAGNOSIS OF PREGNANCY 131
By ROBERT L. DICKINSON, M.D.

CHAPTER V.

DURATION OF PREGNANCY 154
By WILLIAM S. STONE, M. D.

CHAPTER VI.

HYGIENE AND MANAGEMENT OF PREGNANCY 157
By WILLIAM S. STONE, M. D.

PART III.

PHYSIOLOGY OF LABOR.

CHAPTER VII.

PAGE
THE MECHANICAL ELEMENTS OF LABOR 161
By CHARLES JEWETT, M.D.

CHAPTER VIII.

THE MECHANISM AND CLINICAL COURSE OF NORMAL LABOR . . . 195
By AUGUSTUS H. BUCKMASTER, M.D.

CHAPTER IX.

THE MANAGEMENT OF NORMAL LABOR 219
By CHARLES JEWETT, M.D.

PART IV.

PHYSIOLOGY OF THE PUERPERIUM.

CHAPTER X.

THE PUERPERAL STATE AND ITS MANAGEMENT—THE CARE OF THE PUERPERAL WOMAN 259
By HUNTER ROBB, M.D.

CHAPTER XI.

THE NEW BORN CHILD AND ITS MANAGEMENT 277
By ELIAS H. BARTLEY, M.D.

PART V.

PATHOLOGY OF PREGNANCY.

CHAPTER XII.

MULTIPLE PREGNANCY 315
By WALTER P. MANTON, M.D.

CHAPTER XIII.

ABNORMALITIES AND DISEASES OF THE DECIDUA AND FŒTAL APPENDAGES. 320
By WILLIAM S. STONE, M.D.

CHAPTER XIV.

PAGE

PATHOLOGY OF THE FŒTUS—ANOMALIES OF THE FŒTUS 332
By JOSHUA M. VAN COTT, JR., M.D.

CHAPTER XV.

PATHOLOGY OF THE FŒTUS: CONTINUED—DISEASES OF THE FŒTUS . 354
By JOSHUA M. VAN COTT, JR., M.D.

CHAPTER XVI.

ABORTION AND PREMATURE LABOR 362
By HIRAM N. VINEBERG, M.D.

CHAPTER XVII.

ECTOPIC GESTATION. 383
By FERNAND HENROTIN, M.D.

CHAPTER XVIII.

DISEASES OF PREGNANCY 418
By WILLIAM S. STONE, M.D.

PART VI.

PATHOLOGY OF LABOR.

CHAPTER XIX.

ANOMALIES OF THE MECHANISM—ANOMALIES OF THE EXPELLENT FORCES 429
By J. CHALMERS CAMERON, M.D., and J. CLARENCE WEBSTER, M.D.

CHAPTER XX.

ANOMALIES OF THE MECHANISM: CONTINUED—ANOMALIES OF THE PASSAGES—ANOMALIES OF THE FŒTUS 440
By J. CHALMERS CAMERON, M.D., and J. CLARENCE WEBSTER, M.D.

CHAPTER XXI.

ANOMALIES ARISING FROM ACCIDENTS OR DISEASE—PROLAPSUS FUNIS . 520
By CHARLES JEWETT, M.D.

CHAPTER XXII.

ANOMALIES ARISING FROM ACCIDENTS OR DISEASE: CONTINUED—THE HEMORRHAGES 538
By CHARLES JEWETT, M.D.

CHAPTER XXIII.

PAGE

ANOMALIES ARISING FROM ACCIDENTS OR DISEASE: CONTINUED—ECLAMPSIA 559

By J. CLIFTON EDGAR, M.D.

CHAPTER XXIV.

ANOMALIES ARISING FROM ACCIDENTS OR DISEASE: CONTINUED—DIABETES—CARDIAC DISEASE 584

By CHARLES JEWETT, M.D.

PART VII.

PATHOLOGY OF THE PUERPERIUM.

CHAPTER XXV.

ANOMALIES AND DISEASES OF THE BREASTS AND NIPPLES 589

By J. M. VAN COTT, JR., M.D.

CHAPTER XXVI.

PUERPERAL INSANITY 598

By ALLAN MCLANE HAMILTON, M.D.

CHAPTER XXVII.

PUERPERAL INFECTION 605

By J. WHITRIDGE WILLIAMS, M.D.

CHAPTER XXVIII.

MALFORMATIONS, INJURIES, AND DISEASES OF THE NEW-BORN CHILD . 652

By ELIAS H. BARTLEY, M.D.

PART VIII.

OBSTETRIC SURGERY.

CHAPTER XXIX.

THE IMMEDIATE REPAIR OF VAGINAL AND VULVAR LACERATIONS—IMMEDIATE REPAIR OF LACERATED CERVIX 677

By HUNTER ROBB, M.D.

CHAPTER XXX.

PAGE

THE INDUCTION OF ABORTION AND OF PREMATURE LABOR—RETAINED AND ADHERENT PLACENTA 689

By HUNTER ROBB, M.D.

CHAPTER XXXI.

THE FORCEPS 703

By CHARLES JEWETT, M.D.

CHAPTER XXXII.

VERSION 729

By JOHN O. POLAK, M.D.

CHAPTER XXXIII.

EMBRYOTOMY 750

By JOHN O. POLAK, M.D.

CHAPTER XXXIV.

CÆSAREAN SECTION—VAGINAL CÆSAREAN SECTION—THE PORRO OPERATION—SYMPHYSIOTOMY—HEBOTOMY 763

By HUNTER ROBB, M.D.

PLATE I.

PLATE I.

1, internal pudic artery; 2, 3, inferior hemorrhoidal; 4, transverse perineal; 5, superficial perineal (vulvar); 6, common trunk dividing into 7, 8, 9; 7, branch to body of clitoris; 8, artery to the bulb; 9, dorsal artery; 10, 11, 12, 13, 14, internal pudic nerve and branches; 15, anastomotic branch to 16, pudendal branch of 17, small sciatic nerve; 18, terminal branches forming nervous sheath for clitoris; 19, terminal branch of the ilio-inguinal nerve.

A, anus; C, clitoris; M, meatus urinarius; L, great sciatic ligament; V, vagina; O, coccyx; T, tuberosity of the ischium.

a, gluteus maximus muscle; b, sphincter ani externus; c, ischio-coccygeal band of levator ani muscle; d, transversus perinei muscle; e, bulbo-cavernosus muscle; g, erector clitoridis muscle; h, portion of perineal muscle; i, adductor magnus muscle; k, gracilis muscle.

PRACTICE OF OBSTETRICS.

PART I.

ANATOMY.

CHAPTER I.

THE FEMALE PELVIC ORGANS.

THE female organs concerned in reproduction are located in the pelvis. They are usually classified as *external* and *internal*. The external organs include the mons Veneris, the labia majora, the labia minora, the clitoris, and the vaginal orifice. To them collectively is applied the designation *pudendum*. The term "vulva" includes all of the external organs except the mons Veneris. The internal organs are the vagina, the vaginal bulbs, the uterus, the Fallopian tubes, and the ovaries. The ovaries are concerned in germination, the tubes in fecundation, the uterus in gestation, and the remaining organs in copulation.

The terms "external" and "internal," as applied to the organs of generation, have no scientific value. They are retained merely for convenience of description. (Plate I.)

The Perineal Space. If the female be placed upon the back, with the legs flexed and the thighs flexed, abducted, and rotated outward, the perineal space will be exposed. Its landmarks may be made out by palpation. They are the tip of the coccyx, the subpubic arch, and the tubera ischiorum. From the pubic arch to the tuberosity of the ischium upon each side the boundary is bony. It consists of the descending ramus of the pubis and the ramus of the ischium. From the tuberosity of the ischium to the coccyx the boundary is an imaginary line. It corresponds, approximately, to the lower border of the gluteus maximus muscle. It should be observed that the gluteal fold does not coincide with this border, as is sometimes stated.

The Mons Veneris. Above the subpubic arch is an elevated mass of tissue, triangular in outline. The apex of the triangle points toward the perineal space; the base is marked by a fold of skin extending transversely across the hypogastrium; the sides correspond with the folds of the groins. This is the *mons Veneris*. The skin over the mons Veneris is thick. After puberty it is covered with a growth of coarse, curly hair, of a color somewhat darker than that upon the scalp. Underlying the

skin is a quantity of areolar tissue continuous with the superficial fascia of the abdomen, of the thighs, and of the labia majora. It differs from the fasciæ in those regions, however, in possessing greater firmness and elasticity—qualities imparted to it by fibrous bonds or trabeculæ, containing a certain proportion of elastic elements, by which it is traversed. The mons Veneris serves a purely mechanical purpose, and is of interest to the obstetrician as a landmark only.

The Perineum. In the median line of the perineal space appears the anus and the cleft of the vulva. They are about 2.5 cm. apart. The area between the anus and the vulva is, by obstetricians, designated the *perineum*. The skin here is thin, deeply pigmented, and marked by a median raphe along which it is closely adherent to the underlying structures. A raphe, less noticeable, may also be observed extending from the anus to the coccyx. The skin in this situation is not so deeply pigmented nor so closely adherent to the underlying structures as is that over the perineum.

For convenience of description the perineal area is divided by an imaginary transverse line into an anterior, genito-urinary, region, and a posterior, ischio-rectal, region. The dividing line is drawn across the perineum joining the tubera ischiorum; it presents a slight concavity toward the anus.

The Labia Majora. Flanking the cleft of the vulva (*rima urogenitalis*) are the labia majora. Together they are analogous to the scrotum in the male. At the mons Veneris they meet, constituting the *anterior commissure*. Below they merge into the skin of the perineum. To the skin of the perineum limiting the cleft of the vulva the name *posterior commissure* has been applied. Each labium may be compared to a three-sided pyramid. The base is continuous with the mons pubis; the apex is at the perineum; one surface rests upon the pubic ramus, one looks outward toward the thigh, and one looks inward toward its fellow of the opposite side. The outer surface is convex. It is covered with coarse skin, over which extends the growth of hair from the mons pubis. The inner surface is also covered with skin, but of a different character. It is thin and moist and of a reddish color. It is covered with a growth of downy hair, to be seen upon close inspection only. Underlying the skin of the labium majus is a fascia containing fat. The fat is abundant near the mons, but diminishes toward the perineum. Continued into the fascia from the superficial fascia of the perineum is a stratum of elastic tissue. This may be traced as far as the margin of the external abdominal ring. Comparing this fascia with the dartos in the male, some anatomists claim to have demonstrated in it the presence of involuntary muscular fibres. By reason of the presence of the elastic and the muscular elements in the superficial fascia, the skin of the labium may present a corrugated appearance.

The round ligament of the uterus, after emerging from the external abdominal ring, is usually lost in the adipose tissue of the mons. It may extend into that of the labium. In some cases, though rarely, it carries with it a fold of peritoneum. The course of a pudendal hernia is thus accounted for.

At birth there is a slight gaping of the labia majora owing to their incomplete development. In the well-nourished adult virgin they are

PLATE II.

Vulva of Non-parous Woman, Closed.

PLATE III

Vulva of Non-parous Woman, Open. Hymen Intact.

PLATE IV.

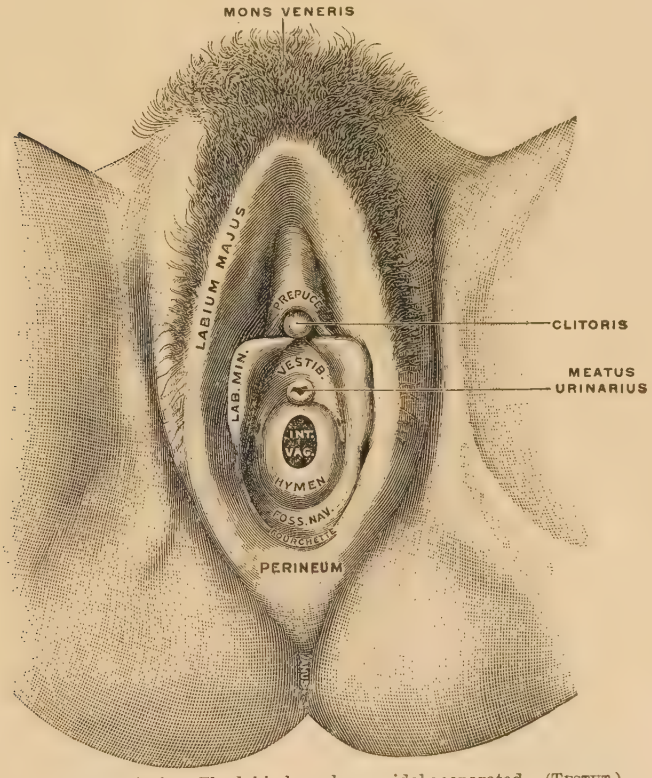
Vulva of Parous Woman, Closed.

PLATE V.

Vulva of Parous Woman, Open.

usually in contact (*vulva connivens*), concealing from view the structures within. In the aged and emaciated they may gape (*vulva hians*), owing to waste of adipose tissue. They may be pressed apart by excessive development of the nymphæ.

FIG. 1.



Vulva of a virgin. The labia have been widely separated. (TESTUT.)

The Labia Minora. By separating the labia majora the *labia minora* or *nymphæ* may be brought into view. They are analogous to the skin of the penis in the male. Each nympha consists of an elongated triangular fold of modified integument. The bases unite medially above the clitoris, and the apices are lost in the labia majora at the sides of the ostium vaginæ. Each presents two surfaces and a free border. In the undisturbed condition of the parts the external surface is in contact with the labium majus of its own side, and the internal surface is in contact with the corresponding surface of the opposite nympha. At the glans clitoridis the free borders bifurcate. The upper divisions unite above that structure, forming a hood-like covering for it, known as its *præputium*, and the lower divisions unite below it, constituting its *frænulum*. The surfaces of the nymphæ are smooth and moist. Sebaceous glands exist upon the external surfaces, but hairs are nearly if not quite wanting. Upon the internal surfaces there are no hairs, and few if any sebaceous glands. A peculiar cheesy material known as *smegma* collects beneath

the prepuce and upon the opposed surfaces of the labia minora. It is not a true sebaceous secretion, but is composed principally of cast-off pavement epithelium cells.

The underlying fascia of the nympha contains no fat, but supports a plexus of veins.

The labia minora, as has been already stated, are visible at the cleft of the vulva in the newborn. In the adult virgin they are pink in color, uniform in size, have unindented borders, and are concealed from view in the undisturbed position of the parts. From frequent copulation, and especially by childbearing, they undergo great changes in shape and appearance. They may assume a bluish color and become pigmented. They may become unevenly elongated and lobulated, and may protrude from between the greater labia. They may also lose their resemblance to mucous membrane and present the appearance of true integument.

The Fourchette. If the labia majora be widely separated, a transverse band of skin appears just above the posterior commissure. This is the *fourchette* or *frænulum pudendi*. When thus demonstrated, a boat-like depression is artificially created between it and the ostium vaginæ. To this has been given the name *fossa navicularis*. Curiously enough, Quain and other well-established authorities describe the fossa navicularis as located between the fourchette and the posterior commissure. There seems, also, to be a difference of opinion as to the histology of the fourchette. Lusk, Skene, and others, following the conclusions of Luschka, describe it as the posterior commissure of the nymphæ. Commonly it is described as a transverse band derived from the labia majora. This discussion, however, is of more interest to the anatomist or medical jurist than to the obstetrician, since the integrity of the fourchette rarely survives the first parturition.

Vessels and Nerves of the Pudendum. The labia majora and the labia minora receive their vascular supply from the superficial perineal branches of the internal pudic arteries. These branches are larger than the corresponding vessels in the male, but they follow similar courses. Each branch arises from the parent trunk near the tuber ischii. It runs along the ramus beneath the superficial perineal fascia to the labium, where it anastomoses with the pudic branch of the femoral artery.

The veins of both the labia majora and the labia minora form rich plexuses which communicate freely with those of the vaginal bulbs. They empty by trunks which accompany the arteries above named. Those of the nymphæ are firmly supported by elastic and by smooth muscular tissue. They become turgid during sexual excitement. They do not, however, as is sometimes erroneously stated, constitute an erectile tissue. The veins of the labia majora are more loosely supported. They frequently present troublesome varicosities during pregnancy. They communicate with the veins of the round ligament of the uterus.

The lymphatics of the vulva empty for the most part into the inguinal glands. A few in the neutral territory between the nymphæ and the vagina may find their way to the femoral chains.

The nerve-supply of these structures is from the internal pudic and the lesser sciatic nerves. The former accompany the arteries of the same name. As they become superficial in the upper part of the perineal space they inosculate with the inferior branches of the lesser sciatic nerves.

Peripheral filaments are richly supplied to the præputium clitoridis, which is regarded by some writers as the seat of voluptuous sensation.

The Vestibule. The separation of the labia minora discloses a space in which may be seen the orifice of the vagina (*introitus* or *ostium vaginæ*). The space is lozenge-shaped. Above it is bounded by the nymphæ as they converge and unite at the frænulum clitoridis. Below it is flanked by the labia majora as they meet at the posterior commissure. The ostium vaginæ is in the lower half of this space. Between it and the posterior commissure are the fossa navicularis and the fourchette. The space above the anterior margin of the vaginal opening is triangular in outline. Some observers claim to have discovered a distinct line of demarcation between the modified skin of the nymphæ and the mucous lining of the genito-urinary tract. Though difficult of ocular demonstration, such a dividing line undoubtedly exists. It is described as following the attached border of the internal surfaces of the nymphæ, crossing beneath the frænulum clitoridis above and skirting the posterior margin of the ostium vaginæ below. To the portion of the space thus bounded, anterior to the ostium vaginæ, is given the name *vestibule.* The floor of the vestibule is marked by faint transverse ridges. For this and other reasons it may be regarded as a continuation forward of the anterior vaginal wall.

The Meatus Urinarius. In the median line of the vestibule, within 1 cm. from the vaginal orifice and about 2.5 cm. from the clitoris, may be observed the opening of the urethra. Its site is marked by an elevation of mucous membrane. This is more prominent anteriorly and has been accepted as a guide for passing the catheter by the sense of touch. As a result of frequent coition, and especially after parturition, this landmark is so far obliterated as to render it of doubtful value. The puckering of the mucous membrane about the urethral opening is caused by the presence of unstriated muscular fibres. A ring of such tissue has been described by Luschka surrounding the ostium vaginæ and the urethra, which is here embedded in the anterior vaginal wall. To it has been given the name *sphincter vaginæ.* Near the meatus urinarius may be seen the openings of several large mucous crypts. They are the *glandulæ vestibuli minores.* They may be so large as to admit the tip of a catheter. Otherwise the mucous membrane of the vestibule resembles that in other parts of the body.

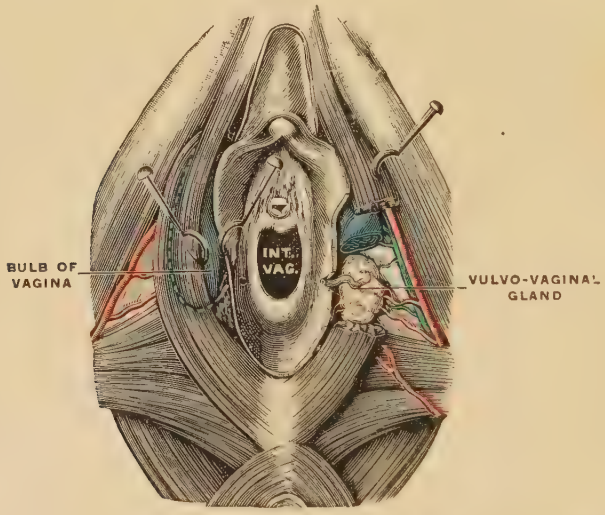
The Glands of Bartholin. Situated at the sides of the vagina near its orifice are two glandular bodies, one upon each side. They are analogous to Cowper's glands in the male, and are named the *glands of Bartholin* or *of Duverney.* Like its analogue, each gland usually lies between the two layers of the triangular ligament. In a very large proportion of instances, however, it is superficial to both layers of the ligament. In either case it is more deeply situated than the vaginal bulb, by the posterior, rounded, extremity of which it is slightly overlapped.

The glands of Bartholin vary in size in different individuals, and frequently upon the two sides in the same person. They attain their greatest development in young adults of voluptuous propensities. They become flattened by childbearing. Like Cowper's glands, they belong to the compound racemose variety. They are of a reddish color and of the form and average size of a common white bean. Each gland is supplied

with a duct about 15 mm. in length and 3 mm. in diameter. This passes obliquely forward or curves round the extremity of the bulb to open between the labium minus and the attached border of the hymen. The duct at its orifice is contracted and can with difficulty be discovered. Its location, however, is usually marked by a vascular area, and may be the better revealed by pressing aside the hymen or the caruncula myrtiformis.

From their location and that of their ducts, the glands of Bartholin are also denominated the *vulvo-vaginal glands*. They are active during sexual excitement only, at which time they secrete a yellow viscid fluid,

FIG. 2.



The vulvo-vaginal gland or gland of Bartholin. (The dotted line indicates the limits of the bulb of the vagina. (TESTUT.)

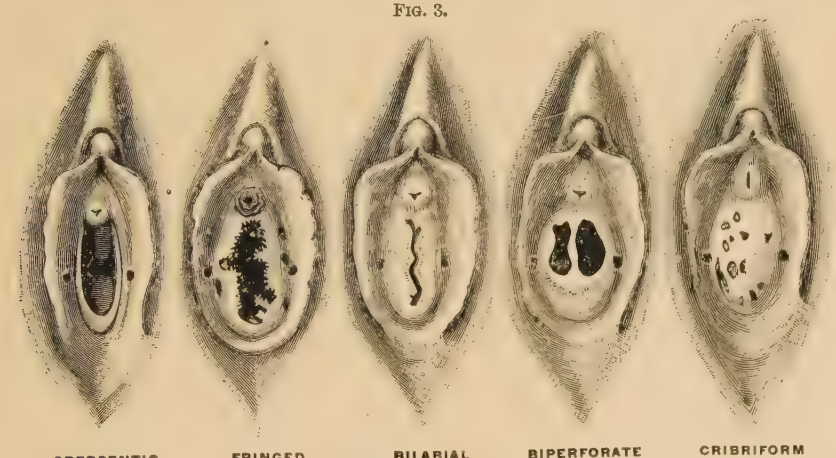
which serves a purely mechanical purpose. They do not develop till puberty, and they become atrophied in the aged.

The deep perineal arteries supply the glands of Bartholin.

The Hymen. The vaginal orifice varies in appearance in different individuals. In the virgin it is partially closed by a structure known as the *hymen*. The hymen is a reduplication of the most inferior portion of the vaginal walls. It, therefore, consists of connective tissue supporting bloodvessels and covered by mucous membrane. Elastic and muscular tissue as well as nerve-fibres may be demonstrated within it. As a rule, it springs from the posterior and the lateral vaginal walls only. In exceptional cases the anterior wall contributes also to its formation. It, therefore, presents a variety of forms. (Fig. 3.) It may completely occlude the vagina (*imperforate*). It may be perforated by numerous small openings (*cribriform*). It may present a central longitudinal cleft. Its common form, however, is crescentic, the free concave border looking toward the anterior vaginal wall. Being crowded inward, it lies in folds, giving to it a fluted appearance.

Usually the hymen is more or less lacerated at the first coitus. (Fig. 4.) Almost without exception it is obliterated at parturition. Thereafter nothing remains of it but fleshy tags attached about the entrance to the vagina. (Fig. 5.) These are called *carunculæ myrtiformes.* From the medico-legal stand-point the absence of a hymen furnishes

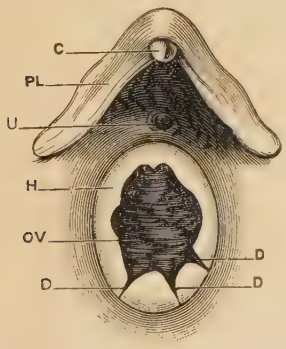
FIG. 3.



Different forms of hymen. (TESTUT.)

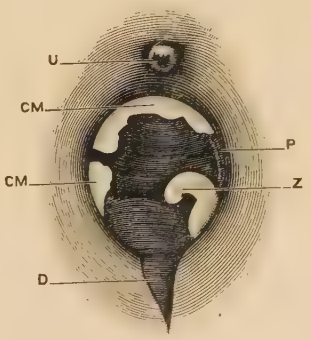
prima facie evidence only of sexual indulgence. It may be absent in the virgin, and has been known to persist in the parous woman. On the other hand, carunculæ myrtiformes are undeniable evidence of a former parturition.

FIG. 4.



Hymen after coitus. (TESTUT.)

FIG. 5.



Hymen after parturition. (TESTUT.)

FIG. 4.—C. Clitoris. PL. Nymphæ. U. Meatus urinarius. OV. Vaginal orifice. H. Hymen. D. Rent in hymen.

FIG. 5.—U. Meatus urinarius. P. Nympha. CM. Carunculæ myrtiformes. Z. Portion of hymen, detached and floating. D. A tear through the fourchette.

When the hymen is intact the exposed ostium vaginæ appears as a vertical slit. When it is destroyed the anterior and posterior vaginal walls are seen to be in contact. The remains of the hymen, however,

may be traced about the orifice in a ring, which is laterally compressed as the vulva is allowed to close. This form of the ostium vaginæ is maintained, no doubt, by the arrangement of the muscular fibres of the pelvic floor.

The Glans Clitoridis. Just above the apex of the vestibular triangle may be seen the *glans clitoridis* surrounded by its prepuce. In the non-turgid condition it is a mere papilla. Frequently it is entirely hidden from view by an elongated prepuce. Occasionally the prepuce is adherent to it, rendering it still more difficult of demonstration. When turgid during sexual excitement it is rarely as large as a small pea.

The glans is the only part of the clitoris which is visible on inspection of the genitalia. It is covered by a modified skin which is extremely delicate and sparingly supplied with sebaceous glands. Sebaceous glands, however, are well developed about its circumference, and secrete an oily substance which emits a characteristic odor.

The Clitoris. The clitoris is not the analogue of the penis, as is so often stated. It corresponds rather to the glans, corpora cavernosa, and crura of that organ. When erect it may be felt, like a rounded cord, about 2.5 cm., 1 inch, in length and 5 mm., $\frac{1}{5}$ inch, in diameter. It arches

FIG. 6.

The clitoris. (After KOBELT.)

A. Bulbus vestibuli. C. Pars intermedia. E. Glans clitoridis. F. Corpus clitoridis. H. Dorsal vein. L. Right crus. M. Vestibule. N. Gland of Bartholin.

upward from the apex of the vestibular triangle to the summit of the subpubic arch. (Fig. 6.) It consists of glans, corpora cavernosa, and crura, in structure similar to the corresponding parts of the penis, but of diminutive size. The trabeculæ of the cavernous bodies are firmer than those in the male organ. The glans is imperforate, and is formed of a plexus of veins continued into it from the bulbs of the vagina. It will be noticed that the corpora cavernosa are formed of true erectile

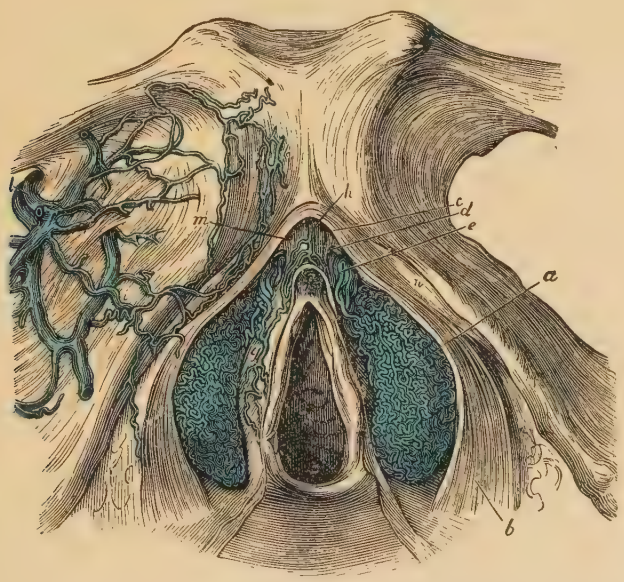
tissue. Not so the glans, though it becomes turgid during the erection of the clitoris.

The clitoris, like its analogue, is furnished with a suspensory ligament. Its mobility, however, is greatly limited by the attachments of the prepuce and of the frænulum.

The vessels supplying the clitoris are disposed in the same manner as the corresponding ones in the male. The same may be said of the lymphatic canals. The nerve-supply to the organ is proportionately much more abundant than that of its analogue. Its source is both from the internal pudic nerves and from the hypogastric plexus of the sympathetic. Nerves from both these sources communicate freely in the organ and form an especially rich network upon the glans. Their method of termination is similar in both sexes.

The Bulbs of the Vagina. Located at the sides of the vagina are the *vaginal bulbs*, more commonly designated the *bulbs of the vestibule.* (Fig. 7.) They are analogous to the bulbous portion of the corpus spongiosum in the male. They lie between the constrictor vaginæ muscle and the anterior layer of the triangular ligament. Relying upon the usual illustrative drawings, one would certainly be disappointed in their appearance, unless an artificially injected specimen were to be examined. Each bulb consists of a plexus of large veins enclosed within a fibrous capsule. When injected it is about 2.5 cm. in length and 12 mm. at its greatest breadth. It is flask-shaped, the bottom of

FIG. 7.



The bulbs of the vestibule. (PLAYFAIR.)

a. Bulb of vestibule. *b*. Muscular tissue of vagina. *c, d, e, f*. The clitoris and muscles. *g, h, i, k, l, m, n*. Veins of the nymphæ and clitoris communicating with the epigastric and obturator veins.

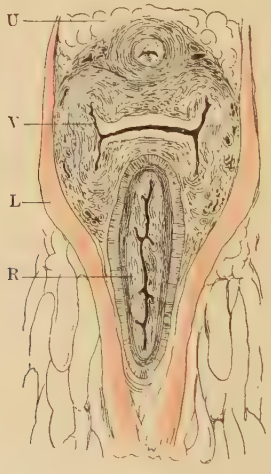
the flask being on a line with the points where the labia minora disappear at the sides of the ostium vaginæ. Anteriorly the bulbs taper and

communicate with each other beneath the clitoris. The isthmus of communication is known as the *pars intermedialis* of Köbelt. The veins of the bulbs communicate freely with the plexuses of the nymphæ and of the labia majora, and also with those making up the substance of the glans clitoridis.

The bulbs of the vagina, though becoming turgid during sexual excitement, do not constitute a true erectile tissue. When turgid they encroach upon the space between the pubic rami, and thus narrow the vaginal orifice.

The Vagina. The vagina is usually described as a musculo-membranous canal leading from the vulva to the uterus. Lying as it does between the bladder and the rectum, its axis varies according to the fulness or emptiness of these viscera. Its axis is also dependent upon the condition of the pelvic floor. With the pelvic floor intact and with the bladder and the rectum empty, the axis of the vagina is nearly parallel with the pelvic brim, except that its lower portion is bulged forward by the perineal body. It is evident that its axis will be rendered more nearly horizontal by a distended bladder and more nearly vertical by a

FIG. 8.



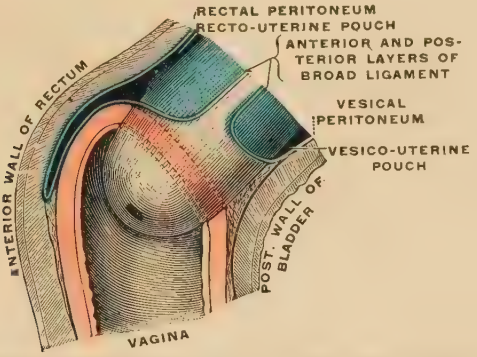
Transverse section of the lower portion of the vagina. (HENLE.)
L. Levator ani muscle. R. Rectum. U. Urethra. V. Vagina.

full rectum. In the virgin, in whom the hymen is still intact, the vaginal opening appears as a vertical slit. When, however, the hymen has been destroyed the anterior and the posterior walls of the vagina are seen to be in contact, and upon cross section its lower end presents an outline resembling the capital letter H. The ostium is much the narrowest part of the canal, even when the latter is distended. A cast of the distended vagina has the shape of an inverted truncated cone, and that this is the shape of the canal may be demonstrated by exploring it with the subject in the genu-pectoral position. The upper expanded portion has been designated the *fornix* or *vault*. Into it from above projects the cervical segment of the uterus. The recesses in front of,

behind, and at the sides of the cervix uteri are distinguished as the anterior, the posterior, and the lateral fornices.

Since the vaginal canal is usually in a collapsed condition, but two walls, the anterior and the posterior, demand description. From what has been already stated, it will appear evident that both walls are wedge-shaped and that the narrow extremities of the wedges are at the ostium vaginæ.

FIG. 9.



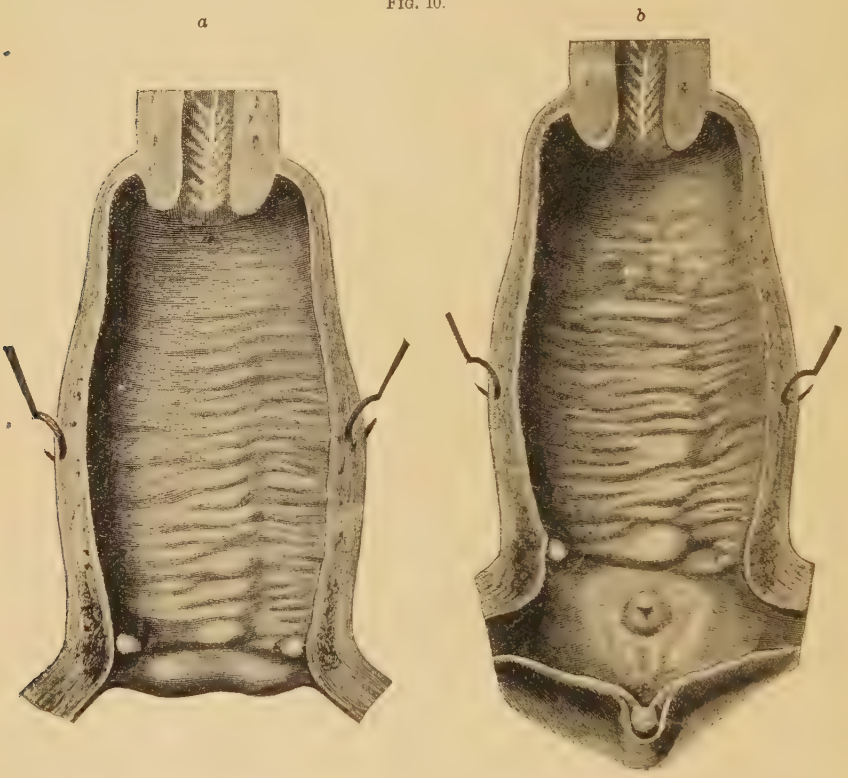
The neck of the uterus and the upper extremity of the vagina, showing their relation to the peritoneum (vaginal walls in red). (TESTUT.)

The capacity of the vagina is increased in every direction by child-bearing. In parous women it may have its greatest breadth through the middle; but, as a rule, it is broadest at the fornix. This breadth varies from 3.5 cm. in nulliparæ to double this measurement in multiparæ. The length of the vagina varies in the different races and in different individuals of the same race. In the negress it is longer as well as more capacious than in women of the white race. Measurements are made along both the anterior and the posterior walls. The average length of the anterior vaginal wall in white women is 6 cm., and of the posterior wall 8.5 cm. The canal is not quite as long in virgins, and it undergoes shortening in senile involution. Cases of congenital shortening are not infrequently met with in which the canal is diminished to half its usual length. The difference in the length of the anterior and of the posterior vaginal walls may create the erroneous impression that the cervix uteri projects through the upper part of the anterior wall, and this impression is strengthened by the greater depth of the posterior fornix.

The vagina is a muscular organ lined by mucous membrane and surrounded by dense areolar tissue. This has led anatomists to describe it as having a fibrous, a muscular, and a mucous coat. Its walls vary in thickness from 5 mm. to 1 cm., $\frac{1}{4}$ to $\frac{1}{2}$ inch. They are thinnest at the fornix and thickest where the urethra is embedded in the anterior wall. This difference in thickness is confined almost entirely to the muscular structure. The muscle is of the unstriated variety and has intermingled with its fibres a certain amount of elastic tissue. Muscular fibres may be made out, taking various courses, circular, longitudinal, and oblique. They interlace, however, in so intricate a manner as to be inseparable into distinct strata. They are continued into the muscular walls of the

uterus above, and below are lost in the structure of the pelvic floor. It is a mistake to state that they are attached to the bony pelvis.

FIG. 10.



Longitudinal section of the vagina. (TESTUT.)

a. Segment showing posterior wall. *b*. Segment showing anterior wall.

The mucous membrane of the vagina is continuous with that of the uterus, and, inferiorly, it covers the hymen and the vestibule. Its epithelium is of the pavement variety. This variety of epithelium characterizes the mucous membrane of the intravaginal surface of the cervix uteri also. The vaginal mucous membrane is from 1 mm. to 1.5 mm. in thickness, and is closely adherent to the underlying muscular wall. In the lower half of the canal each wall is marked by a longitudinal median elevation or furrow—the *columna vaginæ*. This is flanked by transverse ridges—the *rugæ* or *cristæ vaginæ*. The column upon the anterior wall is most marked and seems to originate in the prominent mass of tissue surrounding the urethral opening. The cristæ, which are also best developed upon the anterior wall, are not to be considered as folds of the mucous membrane. They are not obliterated when the vagina is put upon tension, and are due to an alternate thickening and thinning of the mucosa. The markings upon the vaginal walls are most distinct in the infant and in the virgin. They are obscured by childbearing and by catarrhal inflammation.

A sparing secretion of mucus, acid in reaction, is found upon the vaginal walls. Its source is undetermined, since no glands have been demonstrated in the mucosa. The reaction of the secretion has been supposed to be due to the presence in it of an organism known as the *bacillus of Döderlein*. Recent investigation, however, has rendered this theory doubtful.

FIG. 11.

Sagittal section of the uterus to show the manner in which the peritoneum is attached.

A. Body of the uterus. A'. Anterior surface. A''. Posterior surface. B. Neck. C. Isthmus. 1. Cavity of the body. 2. Os internum. 3. Os externum. 4. Posterior fornix. 5. Anterior lip of cervix. 6. Anterior vaginal wall. 7. Posterior vaginal wall. 8. Vesico-uterine septum. 9. Wall of the bladder. 10. Peritoneum. 11. Vesico-uterine pouch. 12. Cul-de-sac of Douglas. (TESTUT.)

The muscular walls of the vagina are surrounded by fibro-cellular tissue. This serves to support a rich vascular network. The relation of the vagina to the tissues forming the pelvic floor has already been considered. A short distance above this floor the posterior vaginal wall comes in close contact with the rectum. This relation is maintained up to the line where the rectum receives its peritoneal covering. The structures between the two canals constitute the *recto-vaginal septum*. Anteriorly the vaginal fornix and the upper part of the canal itself are separated from the urinary bladder by a mass of loose connective tissue. This supports the vesico-vaginal plexus of vessels. The relation of the vagina to the urethra has been already described. The structures between the bladder and the vagina constitute the *vesico-vaginal septum*. Those between the lumen of the vagina and that of the urethral canal form the *urethro-vaginal septum*. Laterally the walls of the vaginal fornix are in relation with the bases of the broad ligaments.

From the foregoing description and that which has already been given of the vesico-uterine pouch it will be understood that the anterior fornix is separated by a considerable distance from the peritoneal cavity. Posteriorly, however, the peritoneum is reflected from the anterior rectal wall forward and upon the vagina. Thence it takes a course upward and to the uterus. The posterior vaginal wall below its attachment to the uterus is thus covered for a certain distance by peritoneum. This distance varies in length from 15 mm. to 3 cm. Thus the posterior for-

nix is in close relation to a peritoneal recess between the rectum and the vagina, designated the *recto-vaginal pouch* or *cul-de-sac of Douglas.* Laterally the cul-de-sac is bounded by peritoneal folds reaching from the upper part of the cervix uteri to the sides of the rectum and past the rectum to the second sacral segment. These are the *folds of Douglas* or the *utero-sacral ligaments.*

In congenital shortening of the vagina copulation is difficult. However, the posterior wall of the vagina may become elongated by repeated acts of sexual congress, thus greatly distending the posterior fornix.

Prolapsus uteri and congenital shortening of the vagina should not be mistaken the one for the other, since in simple prolapsus the uterus may readily be replaced.

The Ischio-rectal Fossa. The ischio-rectal fossa in the female is broader and shallower than in the male; otherwise the anatomy of both is the same. Its form is pyramidal. It is bounded anteriorly by the perineal ledge, externally by the obturator fascia, and superiorly and internally by the anal fascia. It contains firm, coarse areolar tissue of low vascularity and, on that account, is frequently the seat of abscesses. This region is of practical interest to the obstetrician in so far only that in very fat women it may obstruct delivery.

It should be remembered that terminal branches of the pudic arteries and nerves approach the anus from before backward, crossing the external sphincter obliquely.

The Anus. About 2.5 cm., 1 inch, below the posterior commissure of the vulva appears the anus. It is the orifice of the bowel. The skin about the anus is exceedingly delicate and deeply pigmented. It is abundantly supplied with sebaceous glands and covered with a growth of hair. The hair does not grow as profusely, however, as in the male. The skin of the anus is prolonged into the bowel about 1 cm., $\frac{1}{3}$ inch. Owing to the presence in it of unstriated muscular fibres, it is thrown into radiating folds and presents a puckered appearance. To the muscular fibres has been given the name *corrugator cutis ani.*

The subcutaneous veins at the junction of the skin and the mucous membrane of the bowel are loosely supported. For this reason they frequently present varicose enlargements and protrude as *external piles.* The remains of these tumors may persist about the anus in the form of fleshy tags.

The Rectum. The *rectum* is that part of the intestinal tract which extends from the pelvic brim to the anus. At its commencement it lies upon the left sacro-iliac synchondrosis. Throughout its course it presents three well-marked curves. It first curves downward, backward, and toward the right to the hollow of the sacrum. Thence it curves forward to reach and to become attached to the posterior vaginal wall. It then leaves the vagina, from which it is separated in the rest of its course by the perineal body. The three curves are in length 9 cm., 7.5 cm., and 4 cm. respectively. The entire length of the canal is, therefore, about 20.5 cm. The rectum when empty occupies little of the pelvic space, but is capable of great distension. When distended at the time of parturition it may present an obstacle to delivery. Its most dilatable part is about 2.5 cm. above the anus, and is designated the *ampulla.*

The portion extending from the ampulla to the anus is sometimes described as the *anal canal.*

The coats of the rectum are muscular and mucous and are united by submucous tissue. The mucous and submucous structures are similar to those of the colon, except that the former is more vascular. In the mucous coat may be distinguished two strata of unstriped fibres. The fibres of the external stratum are longitudinally disposed and uniformly distributed about the canal. The fibres of the internal stratum encircle the whole of the tube. About the anal canal, down to the external sphincter ani, the circular fibres are augmented so as to form a band 4 mm., $\frac{1}{6}$ inch, in thickness, and 18 mm., $\frac{3}{4}$ inch, in width. This constitutes the *internal sphincter ani* muscle. When the rectum is empty its anterior and posterior walls above the anal canal are in contact. Except

FIG. 12.

Rectum inflated. (CHADWICK.)
a, b. Sphincter tertius. *c.* Ampulla.

when artificially distended or during defecation the anus is closed by tonic contraction of the internal sphincter.

Attention should be called to certain folds of the mucous coat not dissimilar to the valvulæ conniventes in the small intestine. Of these there are three which have been designated the *valves of Houston.* (Fig. 12.) They are arranged transversely or obliquely to the lumen of the tube, and remain unobliterated when it is distended. The longest of them (*plica-transversalis recti*) projects into the rectum from the right. It is about on a level with the cul-de-sac of Douglas. The two others project from the left wall. They are about 5 cm. apart and equally distant above and below the plane of that upon the opposite side. Feces may become impacted above these folds, which fact led Hyrtl to designate them "the third sphincter."

The hemorrhoidal veins are especially abundant in the submucosa. They communicate freely and empty into both the general and the portal circulation. In pelvic obstruction or congestion they may undergo varicose enlargement, and constitute *internal piles.*

The upper third of the rectum is completely invested with peritoneum. This is reflected upon it from as low down as the third sacral segment. The fold of membrane thus formed is denominated the *meso-rectum.* Anteriorly the peritoneum descends upon the rectum to within 6 cm., $2\frac{1}{2}$ inches, of the anus, whence it is reflected upon the vagina. Thus is formed the *recto-vaginal pouch, or cul-de-sac of Douglas.*

The upper part of the rectum lies upon the pyriformis muscle and the sacral plexus of nerves. It has to its left side the left ureter and the left internal iliac artery. Below its peritoneal investment it is united to the sacrum and the coccyx behind, and to the levator ani muscles laterally, by areolar tissue.

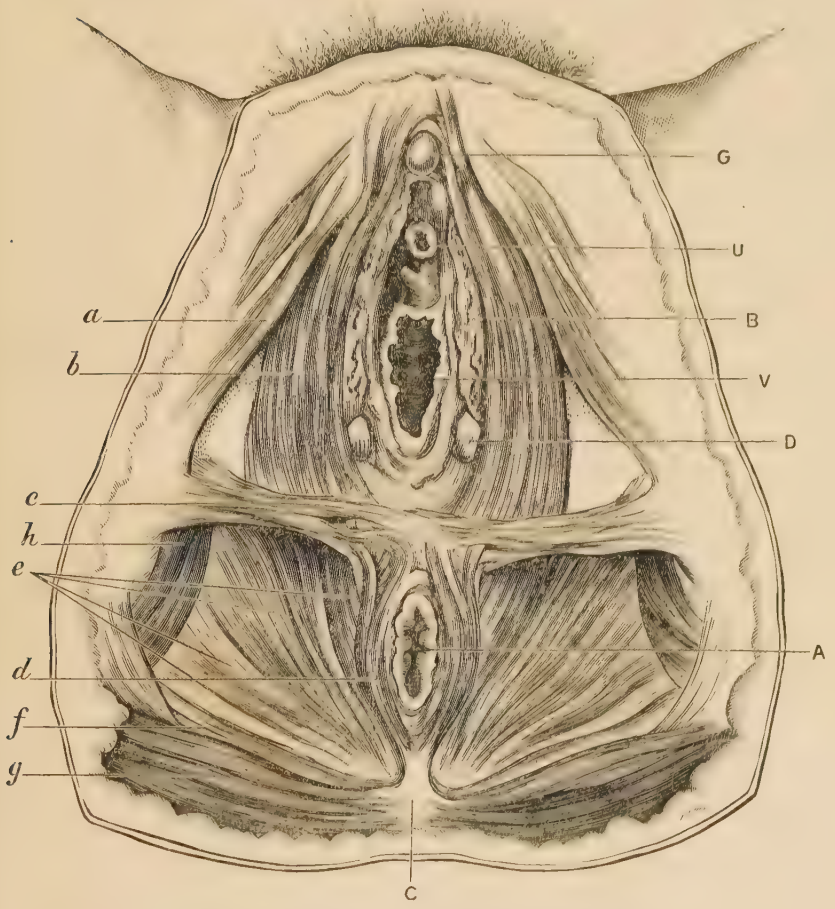
The Pelvic Floor. The pelvic floor consists of the skin, the fascia, and the connective tissue closing in the pelvic outlet, together with certain specialized bands of muscular fibres. It supports the pelvic viscera, none of which nor any part of the peritoneum should be considered as belonging to the floor itself; it is perforated by the rectum and by the vagina; in the anterior wall of the latter canal is the lower end of the urethra. The anatomy of the rectum and of the vagina will be considered later. They are musculo-membranous canals, the orifices of which have already been described as being about 2.5 cm. apart. Within the pelvis the canals approach so that their walls come in contact at about 4 cm. from their orifices.

It may be well to remind the reader that the body is for the most part developed in symmetrical halves. There exists, therefore, a line of union between the lateral halves, and this is usually located in the median plane. Instead of speaking of the structures upon one side of this line as continuous with corresponding ones upon the other, it would be more nearly correct to speak of both as meeting in a median raphe. Inasmuch as vessels and nerves as they approach their terminations diminish in size, it follows that the median raphe is least vascular and least sensitive. (Fig. 13.)

The External Sphincter Ani Muscle. The skin and the fascia extending from the anus to the coccyx are closely adherent along the raphe. Together they constitute the *ano-coccygeal ligament.* From each side of this band or ligament, beneath the superficial fascia, thin, pale sheets of striated muscular fibres arise. They pass forward to blend with those of other muscles at the central point of the perineum, thus surrounding the anus elliptically. With deeper fibres derived from the pubic bands of the levator ani muscles they constitute the *sphincter ani externus* muscle. The function of the external sphincter is to keep the anus closed in response to the will during violent muscular exertions, such as coughing, sneezing, and the like. It forms a *point d'appui* for the other muscles of the perineum, and may aid in expelling the feces at the end of the act of defecation. Loss of its function does not of necessity result in incontinence of feces. The deep fibres derived from the levatores ani pass posteriorly to the anus. Traction upon them separately everts the anus.

Thompson (*Myology of Pelvic Floor*) describes the sphincter ani as made up by three layers of muscular fibre: (1) sphincter ani externus subcutaneus; (2) sphincter ani externus superficialis; (3) sphincter ani externus profundus. Sometimes, particularly in the female, he states that there are only two separate layers. He continues: "The sphincter ani externus subcutaneus is situated immediately beneath the skin, its fibres surrounding the anal aperture decussating in front and behind that

FIG. 13.



Muscles of the pelvic floor. (Modified, from SAVAGE.)

A. Anus. B. Bulbs of the vestibule. C. Coccyx. G. Glans clitoridis. U. Meatus urinarius. V. Vagina. D. Glands of Bartholin. *a*. Ischio-cavernosus muscle. *b*. Bulbo-cavernosus. *c*. Transversus perinei. *d*. Sphincter ani. *e*. Levator ani. *f*. Coccygeus. *g*. Gluteus maximus. *h*. Obturator externus.

opening, posteriorly not reaching to the coccyx, anteriorly passing forward in many cases to become continuous with the innermost fibres of the sphincter vaginæ of the same or of the opposite side." The sphincter ani externus superficialis is the only layer, states Thompson, that is

attached to the coccyx, and he refers to it as the coccygeal part of the muscle. "It arises from the terminal piece of the coccyx, passes forward and divides into halves which come into contact on either side with the lower part of the anal canal. The sphincter ani externus profundus, the deep division of the muscle, forms an annular band of some thickness in contiguity with the puborectal fibres of the levator ani."

The Superficial Fascia of the Perineum. The superficial layer of the superficial fascia of the anal and that of the genito-urinary regions are continuous with each other and with that of the rest of the body. In the genital area of the perineal space a deep layer of the superficial fascia may be demonstrated. It corresponds to Colles' fascia in the male. It is attached to the anterior margins of the descending rami of the pubes, and is continued upon the rami of the ischia as far as the tuberosities. Toward the central line it enters the labia majora, and in them may be traced to the external abdominal rings. Posteriorly it turns around the transversus perinei muscles to join the deep fascia. The deep fascia, otherwise known as the *anterior* or *inferior layer of the triangular ligament*, will be described hereafter.

To expose the remaining muscles of the perineum the deep layer of the superficial fascia must be removed.

The Constrictor Vaginæ Muscle. The *constrictor vaginæ* muscle (sometimes also called the *sphincter vaginæ*) is the analogue of the accelerator urinæ or bulbo-cavernosus in the male. It exercises no such function as its name would suggest, but rather compresses the bulbs of the vagina, which it covers. The muscle consists of thin sheets of striated fibres located upon the sides of the vaginal opening which it thus surrounds. The fibres arise at the perineal body, being closely related to those of the external sphincter ani and of the transversus perinei muscles. Passing over the vaginal bulbs they converge somewhat and are inserted into the sheaths of the corpora cavernosa in front of the insertions of the erector clitoridis muscles. A slip crosses the clitoris and compresses the dorsal vein. It is claimed by Henle that some fibres may be traced into the posterior surfaces of the vaginal bulbs and some into the floor of the vestibule. The constrictor vaginæ muscle is separated by a considerable interval from the vaginal walls.

The Transversus Perinei Muscles. The *transversus perinei* or *ischio-bulbosus* muscles correspond to those of the same name in the male. They differ in that they are relatively smaller in the female. Each muscle arises from the inner surface of the ramus of the ischium just above the tuberosity and between the origins of the obturator internus and the erector clitoridis muscles. It is inserted into the base of the perineal body. The fibres intermingle at their insertion with those of the other muscles meeting at this point. A few fibres deeply situated are inserted in the vaginal wall and some join their fellows from the opposite side in front of the urethra. These latter are sometimes separately named the *deep transversus perinei* muscles.

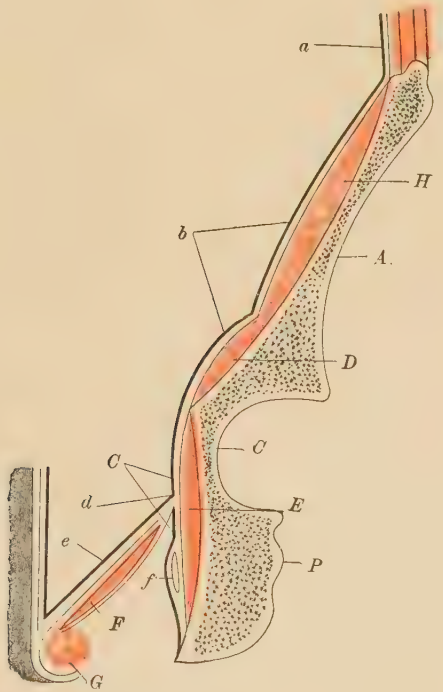
The Erector Clitoridis Muscles. Internal to the origins of the transversus perinei muscles and somewhat nearer to the tuberosities of the ischia arise the *erector clitoridis* or *ischio-cavernosus* muscles. They are of reduced size as compared with their analogues, the erectores penis. As its name indicates, each is inserted into the corpus cavernosum. It

is also inserted into the suspensory ligament. In its course it lies near the ramus of the ischium and the descending ramus of the pubis.

The Perineal Ledge. In the triangular intervals left upon each side between the three last-described muscles may be seen the deep fascia of the perineum. As has been already stated, it is also called the *anterior* or *inferior layer of the triangular ligament.* It consists of a sheet of fascia attached laterally to the ischiatic and the pubic rami and anteriorly to the pubic arch. Posteriorly to the transversus perinei muscles it unites with the deep layer of the superficial fascia. At their line of union these fasciæ are joined by the fascia lining the under surfaces of the levator ani muscles. Thus is formed the *perineal ledge.* The inferior or anterior layer of the triangular ligament is perforated by the vagina and the urethra, between which canals it sends a slip across the vestibule. It is, for this reason, a much weaker structure in the female than in the male.

The Pelvic Fasciæ. An almost complete partition exists between the superficial structures of the pelvic floor and the viscera of the pelvis. It is formed by sheets of fascia and by the levator ani and coccygeus muscles. Since its lateral halves are symmetrical, but one side will be described.

FIG. 14.



Coronal section of the pelvis. (BROWNING.)

A. Ilium. *P.* Ischium. *C.* Acetabulum. *D.* Psoas magnus muscle. *E.* Obturator externus. *F.* Levator ani. *G.* Sphincter ani externus. *a.* Transversalis fascia. *b.* Iliac fascia. *c.* Obturator fascia. *d.* "White line." *e.* Recto-vesical fascia. *f.* Alcock's canal.

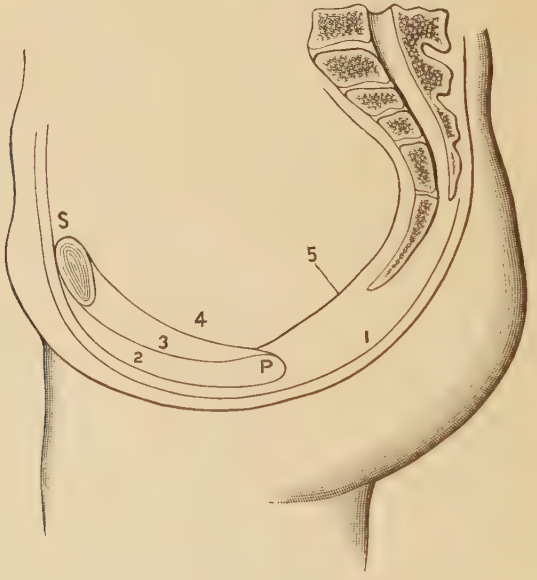
The *obturator internus* muscle arises from the lateral pelvic wall. It is attached to all but a small portion of the lower part of the obturator mem-

brane. It has also a bony origin from the ramus of the ischium and the descending ramus of the pubis contiguous to the obturator foramen and from the bodies of the ischium and of the ilium. From this extensive origin its fibres converge to a tendon which leaves the pelvis through the lesser sciatic foramen. The *pyriformis* muscle arises from the antero-lateral aspect of the sacrum and passes out of the pelvis through the greater sciatic foramen.

The Obturator Fascia is continuous with the iliac fascia and with that covering the pyriformis muscle. Above it looks toward the pelvic cavity and below it forms the external boundary of the ischio-rectal fossa. From this fascia a leaflet is given off, which takes a direction transversely to the pelvis. It is designated the

Recto-vesical Fascia, or *vesical layer of the pelvic fascia.* The line of its attachment to the obturator fascia is the so-called *white line.* The course

FIG. 15.



Sagittal section of the pelvis. (BROWNING.)

S. Symphysis. P. Perineal ledge. 1. Superficial layer of the superficial fascia. 2. Deep layer of the superficial fascia (Colles' fascia in the male). 3. Anterior layer of the triangular ligament. 4. Posterior layer of the triangular ligament. 5. Recto-vesical fascia.

It is to be understood that these planes of fascia are perforated by the urethra, the vagina, and the rectum.

of the white line may be traced from the spine of the ischium to the posterior surface of the body of the pubis in an arc the convexity of which is downward. The lowest point of the arc is a little more than 5 cm., 2 inches, below the pectineal line. By some anatomists that portion of the fascia covering the obturator internus muscle below the white line only is designated the obturator fascia, that above being described as part of the pelvic fascia.

The recto-vesical fascia meets its fellow from the opposite side in a

PLATE VI.

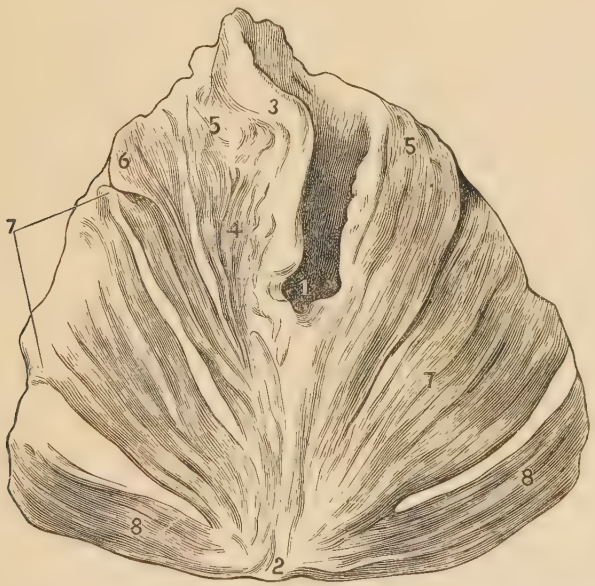
Levatores Ani, viewed from Below. From a Dissection.

1. Fibers arising from os pubis. 2. Fibers arising from the white line. 3. Fibers arising from the ischial spine. 4 Sphincter ani externus. 5. Gluteus maximus.

median raphe. Here it is perforated by the rectum and by the vagina, in the anterior wall of which is the lower part of the urethra. It may be traced into the walls of these canals. Webster has separately described the portion between the bladder and the vagina, that between the vagina and the rectum, and that posterior to the rectum as the *vesico-vaginal*, the *recto-vaginal*, and the *rectal* layers respectively. The following is taken also from the same author: "Further, the arrangement of the visceral [recto-vesical] fascia in the anterior part of the pelvis is of considerable importance. Here the visceral [recto-vesical] layer arising from the back of the lower part of the pubis on each side of the middle line above the point of origin of the anterior fibres of the *levatores ani* as well as the attachment of the parietal [obturator] fascia passes backward as two strong bands above them and on each side of the urethra, to become blended with the anterior surface of the bladder. These are the *anterior true ligaments* of the bladder. Between them is a space filled with loose connective tissue and fat, continuous below with the retro-pubic fat and above with the suprapubic or retro-peritoneal fat."

Just external to the anterior true ligaments, as above described, portions of the recto-vesical fascia are reflected upon the bladder as its *lateral true ligaments*.

FIG. 16.



Drawing from a cast of a dissection made at the Long Island College Hospital. (BROWNING.)

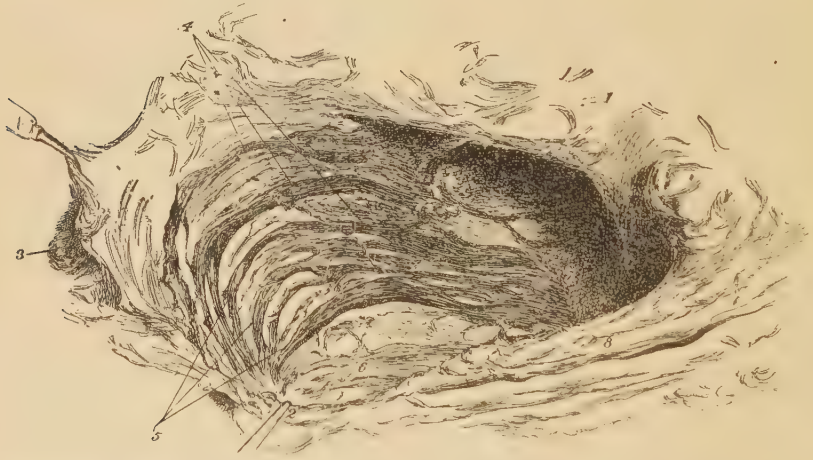
1. Rectum. 2. Coccyx. 3. Labium minus. 4. Sphincter ani externus. 5. Fibres of the levator ani arising from the os pubis. 6. Fibres arising from the triangular ligament. 7. Fibres arising from the "white line." 8. Fibres arising from the spine of the ischium.

The Superior or Posterior Layer of the Triangular Ligament. From the obturator fascia along its attachment to the ramus of the ischium and to the descending ramus of the pubes a fascia is derived which meets its fellow in the median line. It is superficial to the levator ani muscle and blends with its sheath. In the middle line it is continued into the sheath

of the vagina and unites with the recto-vesical fascia. By union with the corresponding structure of the opposite side a triangular sheet is formed which is perforated by the vagina and the urethra. Its apex is at the subpubic arch and its base joins the anterior or inferior layer of the triangular ligament at the perineal ledge. To this structure, weak in character, has been given the name *superior or posterior layer of the triangular ligament.*

The Levator Ani Muscle. Underlying (*i. e.*, superficial to) the recto-vesical fascia is the *levator ani* muscle. Respecting its origin anatomists are practically agreed, but the direction of its fibres and their insertion has been variously described. It arises from the intrapelvic surface of the body of the os pubis and from the posterior layer of the triangular ligament, from the spine of the ischium and from the whole length of the white line. The fibres arising from the pubis, those from the white

FIG. 17



Drawing from a photograph of a dissection made at the Long Island College Hospital; individual fibres of the levator isolated. (BROWNING.)

1. Symphysis pubis. 2. Coccyx. 3. Anus. 4. Deep fibres from pubic origin. 5. Fibres from fascial origin. 6. Fibres from ischial spine. 7. White line. 8. Gluteus maximus muscle.

line, and those from the ischium are sufficiently distinct as to their arrangement and as to their insertion to entitle them to separate description, if not to entitle them to be considered separate muscles. The area of pubic origin is located about 12 mm. from the symphysis and 3.5 cm. below the upper border of the bone to the anterior limit of the white line. The fibres arising here are joined by those from the posterior layer of the triangular ligament. This latter structure blends with the obturator fascia along the descending pubic ramus. It will thus be seen that the origin of the pubic portion of the levator is more extensive than usually described, and that its plane is superficial to and intersects that of the portion arising from the white line. The fibres, arising as above described, soon gather to form a band, about 12 mm. wide and 3 mm. thick, and distinctly separable from the rest of the muscle. It takes a course nearly horizontally backward toward the anus. "At its insertion

it is bilaminar. The posterior lamella sweeps backward by the lateral wall of the vagina and rectum, and is attached to the coccyx. This is the *pubo-coccygeus*. The anterior lamella runs toward the perineal flexure of the rectum. A few of its fibres passing in front of the bowel become continuous through the intervention of tendon with the opposite transversus perinei muscle; a few go to the rectal sheath, others extend into the external sphincter ani of which they form a part. The latter division of the pubic band is the *pubo-rectalis*. When intact these muscles may be felt in the living subject by the examining finger. They present as two small firm, more or less rounded cordlike bands often thinner than a lead pencil. The course of each may be traced from the posterior surface of the pubic bone backward to the perineal flexure of the rectum. Just behind the *pubo-rectalis* and running obliquely backward is the *pubo-coccygeus*. When these two pairs of muscles contract, the finger held in contact with the posterior vaginal wall is lifted forward toward the pubic arch" (Jewett).

FIG. 18.

Drawing from a photograph of the dissection of the pelvis of a young primipara just after parturition. The levator ani cleaned and intrapelvic pressure removed. (BROWNING.)

1. Symphysis. 2. Coccyx. 3. Anus. 4. Tuberosity of the ischium. 5 Fibres from pubic origin. 6. Fibres from "white line." 7. Fibres from the spine of the ischium.

The fibres of the levator arising from the ischium arise from the inner aspect of the spine contiguous to and just in front of the coccygeus muscle. They form a spindle-shaped bundle, thicker, somewhat more superficial than, and distinctly separable from the fibres of fascial origin. They may also be distinguished by their darker color. The course of the bundle is nearly transverse, and it is for the most part inserted into the fourth coccygeal segment. A few superficial fibres turn forward upon the recto-coccygeal raphe.

The portion of the levator intermediate between those already described is thin and membranous. It consists of a number of fascicles which arise from a fascia weakly attached to the white line. Even in well-

developed women the fascicles exhibit fascial intervals. In the aged and emaciated they undergo a marked degree of atrophy and degeneration. Their direction is downward, backward, and inward with varying obliquity toward the rectum and the recto-coccygeal raphe. The anterior are the most oblique and the posterior are nearly transverse. As they approach the rectum and the raphe they turn backward and course in a direction nearly parallel with the median line; most of them reach the coccyx; some become aponeurotic before doing so.

The levator ani muscle is lined by a thin fascia which adheres closely to it. It is known as the *anal* fascia, and can readily be dissected from the recto-vesical fascia. When thus dissected a delicate fascia may be demonstrated upon the upper surface of the muscle. This with the anal fascia constitutes its sheath. In the median line, extending from the rectum to the coccyx, the sheath of the levator ani muscle blends with the recto-vesical fascia forming the recto-coccygeal raphe. At the perineal body also and at the sides of the vagina and of the rectum these structures blend.

The recto-vesical fascia constitutes a support for the pelvic contents. By the contraction of the levatores ani this support is raised and the pelvic viscera elevated. The post-vaginal structures are also drawn for-

FIG. 19.

The external genitals, as seen in mesial section. (HENLE.)

a. Anus. *b*. Perineal body. *c*. Vagina. *d*. Urethra. *e*. Labium minus. *f*. Clitoris. *g*. Fossa navicularis, in front of which is the hymen.

ward. A very noticeable result of traction upon the pubic band is to evert the anus.

Those who have conducted investigations upon the lower animals will have observed the proportionately greater development of the levator ani in those possessed of a tail, and that its function in such animals is almost entirely to act upon that structure.

The triangular interval between the posterior border of the levator ani muscles and the anterior border of the pyriformis is filled in by the coccygeus. This is a thin muscular sheet. It arises from the spine of the ischium, and, spreading out fan-shaped, is inserted into the side of the coccyx and of the sacrum adjoining.

Savage, in his description of the pelvic floor, gives to the pubic portion of the levator the name "pubo-coccygeus;" to the rest of the muscle the name "obturato-coccygeus," and to the coccygeus the name "ischio-coccygeus."

The Perineal Body. It is unfortunate that the term "perineum," when treating of the female, is used somewhat ambiguously. By anatomists it is applied without distinction of sex to the whole perineal area. By obstetricians and gynecologists it is, as a rule, applied only to that span of tissue intervening between the anus and the posterior commissure of the vulva. This source of confusion is not cleared up by designating this latter area "the perineum *proper*." What obstetricians call the perineum or perineum proper corresponds to the central tendinous point in the male.

It has already been shown that underlying the skin and the superficial fascia of this limited space several muscles intermingle their fibres. They are the sphincter ani externus, the constrictor vaginæ, and the tranversus perinei. By the union of the deep layer of the superficial fascia and the deep fascia of the perineum (anterior layer of the triangular ligament) a strong resisting band (the perineal ledge) is formed. This stretches between the tuberosities of the ischia, and in crossing meets the anterior limit of the external sphincter ani muscle. These structures meeting at the central point of the perineum, together with the areolar, elastic and involuntary muscular tissue disposed between and about them, form the larger and by far the most important part of what has been designated the *perineal body*.

It has already been stated that the rectum and the vagina, though opening at a distance from each other of 2.5 cm., come in contact at about 4 cm., from their orifices. The *perineal body* is the aggregation of tissues included between these canals below their contact. It is usually described as triangular in outline upon sagittal section, and pyramidal in form. When the rectum and the vagina are flaccid it is gourd-shaped rather than pyramidal. The tissues forming its expanded portion or base have been already described. So much of the body as lies above the pelvic fascia does not differ essentially in structural character from the connective tissue disposed elsewhere among the intrapelvic viscera.

The Bladder. The *bladder* is a hollow muscular organ lined with mucous membrane. It is more or less intimately connected to surrounding parts by dense fibrous or by loose areolar tissue. In structure and function it does not differ in the sexes. It will be necessary in a work of the scope of this to call attention only to certain peculiarities of form in the female bladder and to such relations as are of interest to the obstetrician. Its capacity is stated to be somewhat less than that of the male bladder, though, under some circumstances, it is more distensible. It is interposed between the symphysis pubis in front and the uterus and the vagina behind. The *neck* surrounds the urethral opening. It, as a rule, is the most dependent portion of the organ when the erect position of the body is assumed. The circular muscular fibres are here augmented somewhat, and the mucous membrane presents a puckered appearance. To the reinforced circular fibres has been given the name *sphincter vesicæ*. This name, however, is misleading, since there exists here no true sphincter. The term "neck" is also unfortunate in the description of the bladder, for the reason that the entrance of the urethra is abrupt and not gradual. The uvula is less distinct and the trigone is smaller than in the male bladder. The triangle, at the angles of which are located the urethral opening and the ureteric orifices, is more nearly equilateral, each leg measuring about 3.5 cm.

At a variable distance above the pubic bone the peritoneum is reflected from the anterior abdominal wall to the summit of the bladder. The space under this membrane and between the anterior bladder-wall and the pubes is known as the *cavity of Retzius*. It is occupied by a mass of loose areolar tissue which allows considerable mobility to the viscus.

FIG. 20.

Sagittal section of the female pelvis. (TESTUT.)

Posteriorly the bladder is connected with the upper part of the vagina and with the cervix uteri by a firmer connective tissue. From the summit of the bladder the peritoneum is reflected upon the uterus at about the level of the os internum, forming the *vesico-uterine pouch*.

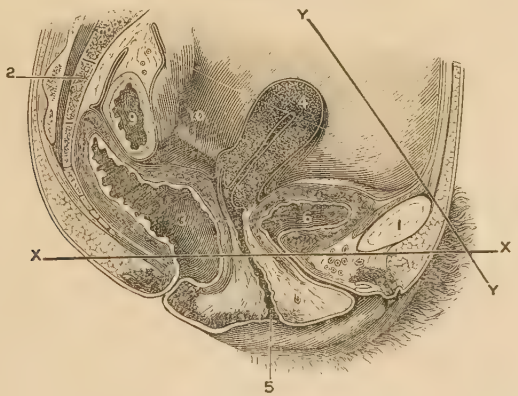
When empty the bladder sinks below the pelvic brim and the fundus of the uterus falls forward upon it. The vesico-uterine pouch is then

collapsed and the intestines rest upon the posterior uterine wall. When distended the bladder rises into the abdominal cavity. It carries the uterus upward and pushes it backward, and coils of intestine may fall into the vesico-uterine pouch.

The distended bladder of the adult female is ovoid, the long axis being transverse. That of the child and that of the aged assume more nearly the masculine type. When empty the bladder sinks beneath the pelvic brim and the uterus drops forward upon it. Upon sagittal section the long axis of the collapsed bladder would form nearly a right angle with that of the vagina.

The Urethra and the Urethro-vaginal Septum. The *urethra* of the female is about 3.5 cm. in length. Its axis is nearly parallel with the plane of the pelvic brim. Its lower three-fourths is embedded in the anterior vaginal wall. Its upper fourth is separated therefrom by a mass of cellular tissue. The average diameter of the canal is 5 mm. though it is very dilatable. Its walls are muscular and lined with mucous membrane. The mucous membrane is thrown into longitudinal folds by the presence of elastic fibres in the submucosa. The muscular wall consists of two distinct strata of smooth fibres. Those of

FIG. 21.



X. Plane of pelvic outlet. Y. Plane of pelvic inlet. 1. Symphysis. 2. Sacrum. 3. Rectum. 4. Uterus. 5. Vagina. 6. Bladder. 9. Sigmoid flexure of the colon. 10. Utero-sacral ligament. (TESTUT.)

the internal stratum are longitudinal in direction, continuous with the longitudinally disposed fibres of the bladder. The external stratum is continuous with the sphincter vesicæ. In the upper fourth of the urethra the external fibres encircle the canal. In its lower three-fourths they may be demonstrated anteriorly to it only, being continuous posteriorly with the circular fibres of the vagina. The striated fibres from the deep transversus perinei muscles which meet in front of the urethra are sometimes described as the *compressor urethræ or Guthrie's muscle.* Some investigators claim to have demonstrated the presence of voluntary fibres encircling the upper part of the canal, which they contend act as a voluntary sphincter. The arrangement of the sphincter vaginæ of Luschka, whereby the urethra is compressed against the urethro-vaginal septum has already been alluded to.

The *urethro-vaginal septum* may be nearly or quite 1.5 cm. in thick-

ness in the lower three-fourths. Above, the canals are more widely separated by the interposition of cellular tissue. An idea of the relative position of the parts, as well as of the thickness of the septum, may be gained from the following statement: If a line be drawn from the middle of the posterior surface of the symphysis pubis to the cervix uteri, its length would be about 5 cm., and the vesical opening of the urethra would be located at about the union of the anterior and middle thirds. Quain states that the female urethra corresponds to the prostatic portion in the male. There seems, however, to be no ground for making so definite a statement.

Fig. 22.

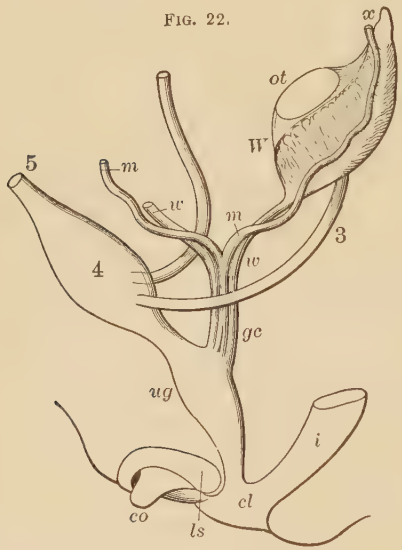


Diagram of the primitive uro-genital organs in the embryo previous to sexual distinction. The parts are shown chiefly in profile, but the Müllerian and Wolffian ducts are seen from the front. 3. Ureter. 4. Urinary bladder. 5. Urachus. *ot.* The mass of blastema from which ovary or testicle is afterward formed. *W.* Left Wolffian body. *x.* Part at the apex from which the coni vasculosi are afterward developed. *w, w.* Right and left Wolffian ducts. *m, m.* Right and left Müllerian ducts uniting together and with the Wolffian ducts in *gc*, the genital cord. *ug.* Sinus urogenitalis. *i.* Lower part of the intestine. *cl.* Common opening of the intestine and uro-genital sinus. *co.* Elevation which becomes clitoris or penis. *ls.* Ridge from which the labia majora or scrotum are formed. (Gray.)

Throughout, the mucous membrane of the urethra presents the orifices of tubular glands. Two tubules, much larger than the rest, open upon the floor of the urethra near the meatus. Their mouths are not readily discernible, except under pathological conditions. They are known as Skene's glands.

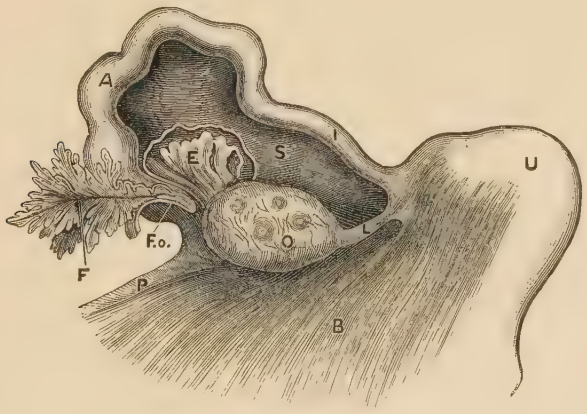
Development of the Sexual Organs. At the beginning of the seventh week the embryonic structures from which the reproductive organs are to be developed present the same appearance in both sexes. The intestinal and genito-urinary canals discharge into a common chamber or *cloaca*. Just within the cloaca, anteriorly, is an elevation of tissue representing the future external organs of generation. The canal leading to the bladder is comparatively large and is known as the *uro-genital sinus*. In the lumbar region are two glandular structures, one upon each side. They are the *Wolffian bodies*. From their lower extremities the *Wolffian ducts* lead inward and downward to the uro-genital sinus. Upon each side another tubular structure may be observed. Above, it lies upon the external surface of the Wolffian body. At the lower extremity of the Wolffian body it crosses the Wolffian duct, from without inward, and, turning downward, runs along its inner side to reach the uro-genital sinus. This is the *duct of Müller*. Medially the lower portion of the ducts of Müller are in contact. Subsequently the partition between them disappears, and the single tube, thus resulting, becomes the "foundation of the vagina and uterus in the female, and the prostatic vesicle or uterus masculinus in the male; the upper or forepart of the Müllerian duct disappears in the male; in the female it forms the

oviduct" (Quain). Arrest of development will explain the congenital malformations of double uterus and double vagina.

The reproductive gland (testicle or ovary) is developed from the Wolffian body. The Wolffian body is held to the posterior abdominal wall by a reflection of peritoneum from which a fold passes downward to the groin. After the atrophy of the parent structure its peritoneal investment forms the mesovarium or mesorchium, as the case may be, and the descending fold (*plica gubernatrix*) becomes the gubernaculum testis in the male and the round and ovarian ligaments in the female. The Wolffian duct, which in the male develops into the vas deferens and the epididymis, disappears, for the most part, in the female. A remnant, however, corresponding to the globus major, persists as a rudimentary structure, and is described under the name of the *parovarium* or *epoöphoron*.

As is the case with the testis, so the ovary migrates. Its descent is arrested, however, by the plica gubernatrix becoming attached to the Müllerian duct. This accounts for the permanent location of the ovaries and for the attachment of the ovarian and the round ligaments to the uterus.

FIG. 23.



Fallopian tubes.

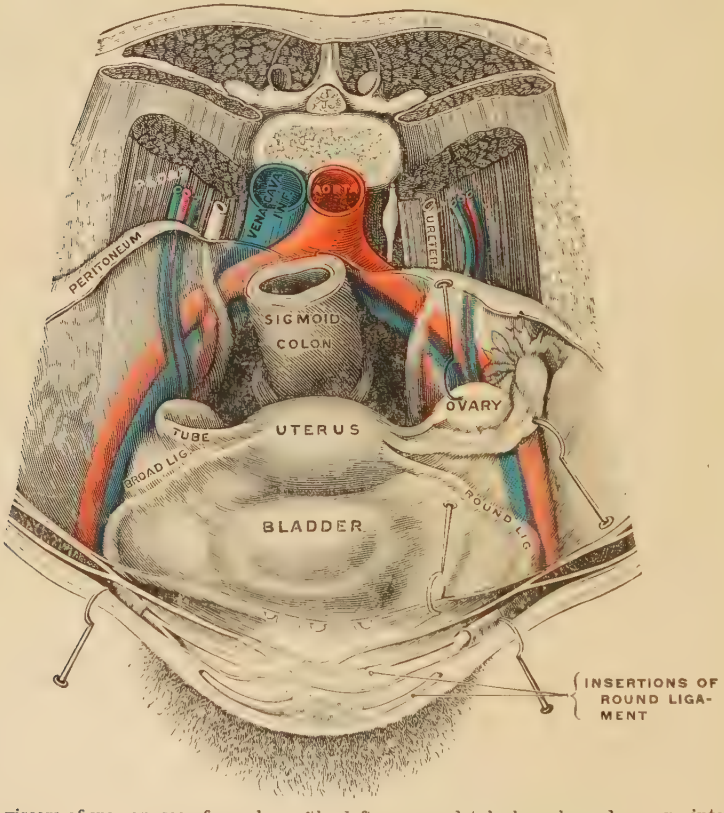
U. Uterus. I. Isthmus. A. Ampulla. F. Fimbriæ. F.o. Fimbria ovarica. S. Mesosalpinx. O. Ovary. L. Ligamentum ovaricæ. P. Ligamentum infundibulo-pelvicum. E. Parovarium. (HENLE.)

The Fallopian Tubes. The *Fallopian tubes*, for the reason that they conduct the discharged ova to the uterine cavity, have been denominated the *oviducts*. They are within the folds of the broad ligaments and occupy their superior borders, reaching from the cornua of the uterus nearly to the lateral pelvic walls. They vary in length from 7.5 cm. to 12.5 cm. As a rule, the right tube is somewhat the longer of the two. In their development the Fallopian tubes may be considered as finally penetrating the broad ligaments, so that they open into the peritoneal cavity. The broad ligaments surround them much as the peritoneum does the small intestine. Since to the tube is applied the technical name "salpinx," the designation *mesosalpinx* is given to that portion of the broad ligament included between the tube above and ovary and the utero-ovarian ligament below. The appearance of the distal end of each tube is that of a ragged tear through the broad ligament above and just

external to the ovary. From this point to the lateral pelvic wall the superior border of the broad ligament is firm and reinforced by fibrous tissue. It presents a sharply concave outline. It forms the *ligamentum infundibulo-pelvicum* or *ligamentum suspensorium ovarii.*

It is quite evident that the position of the broad ligaments, and consequently that of the ovaries and of the tubes, will vary with that of the uterus. The latter organ is not firmly fixed in the pelvic cavity and its fundus is especially movable. Concerning the usual position of the uterus there has been much controversy. From the intimate connection

FIG. 24.



The pelvic viscera of woman, seen from above (the left ovary and tube have been drawn up into the left iliac fossa). (TESTUT.)

of the cervix to the bladder, anteriorly, and of its proximity to the rectum, posteriorly, it will be understood that the direction of the long axis of the uterus will vary according to the contents of these viscera. When the bladder and the rectum are both empty, the fundus of the uterus will drop forward so that the long axis of the uterus will form nearly a right angle with that of the vagina, and the uterus will sink wholly beneath the plane of the pelvic brim. There may also exist in the organ a certain degree of anteflexion. The broad ligaments will now arch about the pelvic walls from before backward, and their uterine will be on a

lower level than their pelvic attachments. When the bladder fills the fundus uteri is pushed upward and backward, and may rise above the plane of the pelvic brim. The long axis of the uterus becomes then more nearly vertical, and the broad ligaments with the uterus assume the position described as a transverse pelvic partition.

When the uterus is in its anteverted position the Fallopian tubes, springing from its cornua, curve about the pelvic brim, superiorly to the ovaries, and turn downward and backward around the distal extremities of these organs. The fimbriated extremities of the tubes are on a level with the lower border of the ovaries, posterior to them. The curves in the tubes are inherent in them, and are not due to their position against the pelvic walls, as may be proven by studying them when the uterus with its adnexa is removed from the body.

FIG. 25.

Left ovary turned up, showing the surface usually in contact with the broad ligament; shows also the fimbria ovarica and the fimbriated extremity of the Fallopian tube. (BROWNING.)

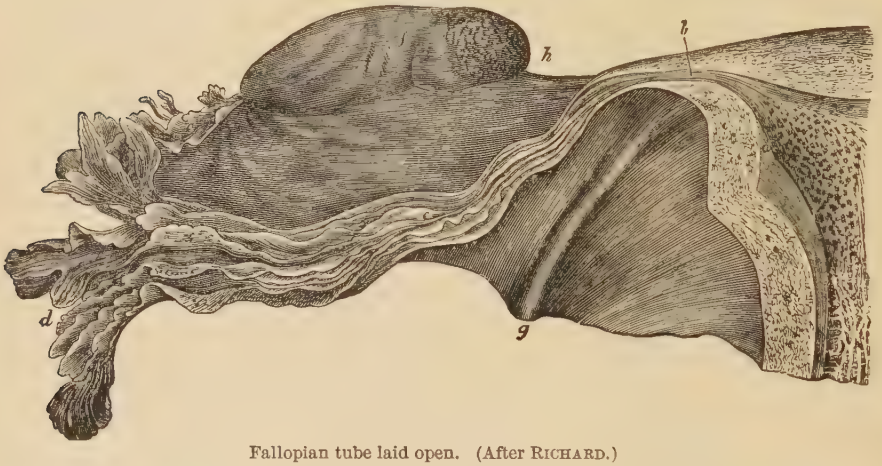
G. The ovary. H. Line of limitation between the ovary and the broad ligament. E. Fimbriated extremity of the Fallopian tube. M. Fimbria ovarica. The letter M' lies above the infundibulopelvic ligament, which is cut at the pelvic end.

The Fallopian tubes are muscular structures and are lined by an extension of the mucous membrane from the uterus. At their distal extremities the mucous membrane meets the serous surface of the peritoneum. The muscular coat of each tube may be divided into an external and an internal layer. The fibres of the external layer are longitudinal and are continuous with the external stratum of the uterus. Those of the internal layer encircle the tube and are continuous with the internal stratum of the uterus. The circular fibres are greatly increased in number where the tube opens into the uterine cornu.

The oviduct differs so much in form, in diameter, in calibre, and in appearance in different parts of its length, as to have led to its division

into four portions. These are the isthmus, the ampulla, the neck, and the fimbriated extremity. The isthmus extends from the uterus for about two-sixths of the whole length of the tube. Its diameter is about 3mm.,

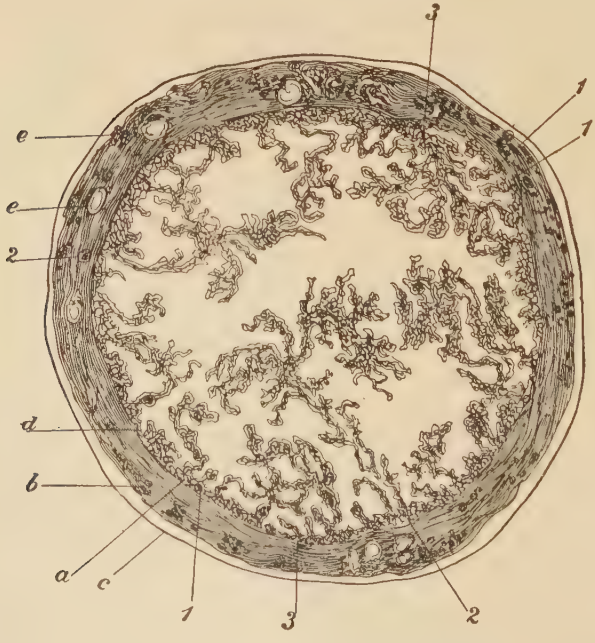
FIG. 26.



Fallopian tube laid open. (After RICHARD.)

a, b. Uterine portion of tube. *c, d.* Plicæ of mucous membrane. *e.* Tubo-ovarian ligaments and fringes. *f.* Ovary. *g.* Round ligament.

FIG. 27.

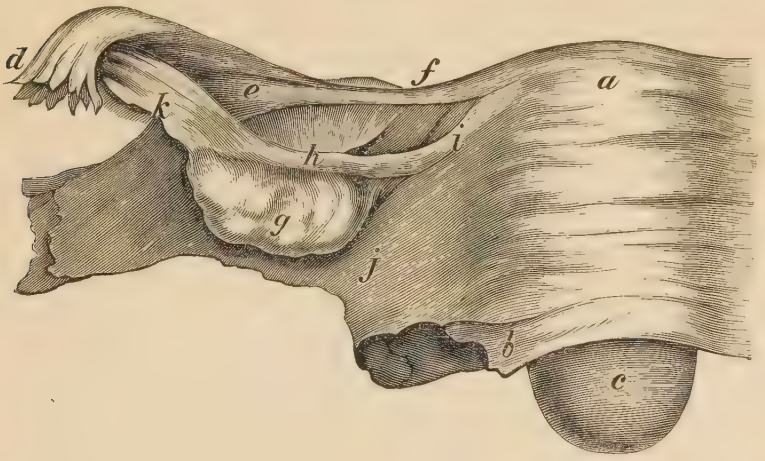


Fallopian tube; cross section through ampulla, under low power. (After LUSCHKA.)

a. Submucous layer. *b.* Muscular layer. *c.* Serous coat. *d.* Mucous membrane. *e, e.* Vessels. 1, 1. Small primary folds. 2, 2. Larger longitudinal and accessory folds. 3, 3. Small folds united forming canaliculi.

$\frac{1}{8}$ inch. Its calibre at the uterine opening is small, admitting but a very fine bristle, but it gradually enlarges toward the ampulla. It has a solid or cord-like feel. The ampulla occupies three-sixths of the length of the tube, and extends from the isthmus to the neck. It is the most tortuous portion, the curve of which has been already described. Its diameter increases from the isthmus to the neck, and may reach a maximum of 1 cm., or a little more than one-third inch. The diameter of its lumen is half that of the tube itself, thus rendering the ampulla less firm to the touch than is the isthmus. The distal sixth of the Fallopian tube displays a "funnel-shaped expansion surrounded by a fringe of peculiar fleshy processes, which recall in a striking manner the tentacles of a sea-anemone" (Coe). These ragged fringe-like processes are denomi-

FIG. 28.



Uterus, Fallopian tubes, ovaries, and broad ligaments seen from behind. (BROWNING.)

a. Fundus of uterus. *b*. Attachment of utero-sacral ligament. *c*. Cervix. *d*. Fimbriated extremity of Fallopian tube. *e*. Ampulla of same. *f*. Isthmus of same. *g*. Ovary. *h*. Line of limitation between ovary and broad ligament. *i*. Ovarian ligament. *j*. Posterior surface of broad ligament. *k*. Fimbria ovarica.

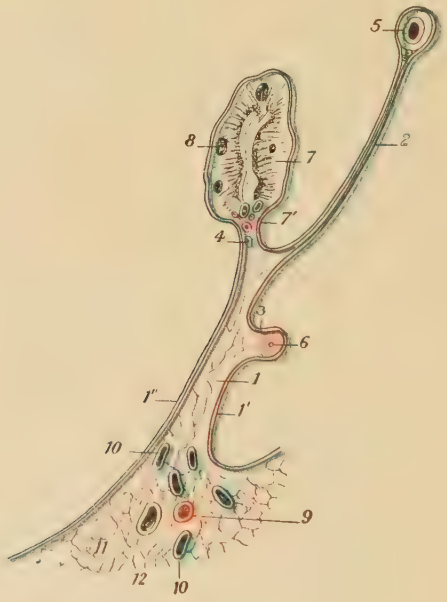
nated *fimbriæ*, and they give to this portion of the tube the name *fimbriated extremity*. It is the "morsus diaboli" of the ancient anatomists. The *neck* of the Fallopian tube marks the union between the ampulla and the fimbriated extremity. Distally the canal of the tube terminates in the *ostium abdominale*. Quain cites authority for the statement that this orifice is physiologically closed during life, though dilatable to the extent of 4 mm. The expanded mucous-lined portion of the tube distad to the ostium abdominale is designated the *infundibulum* or *pavilion*. The primary fimbriæ are four or five in number, but they send secondary offshoots from their edges, presenting a complex appearance. One of the primary fimbriæ, larger and less complex than the others, is attached to the outer extremity of the ovary. It is known as the *fimbria ovarica*.

The mucous lining of the Fallopian tubes is not as closely adherent to the muscular structure as is that in the body of the uterus. However, it has no distinct submucosa. It is disposed in longitudinal folds,

which are somewhat more complex in the ampulla than in the isthmus. This gives to the lumen of the tube on cross section a stellate appearance. The furrows are continued upon the fimbriæ, so that the fimbria ovarica presents a gutter leading from the ovary to the pavilion. The epithelium is of the columnar variety and ciliated throughout. The cilia possess remarkable activity and produce a current toward the uterus. The *hytadids* or *cysts of Morgagni* are little bodies sometimes found attached by pedicles to the fimbriæ or to the broad ligaments adjacent thereto. They are remnants of fœtal structures.

The Ovaries. The *ovaries* are the reproductive glands of the female and are the analogues of the testicles in the male. Each is an almond-shaped body varying in weight and dimensions according to its functional activ-

FIG. 29.



Sagittal section through the ovary and broad ligament.

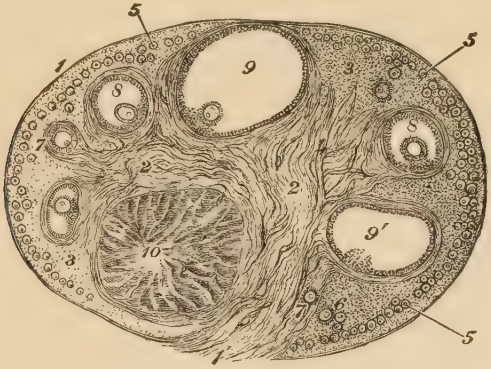
1. Broad ligament. 1'. Anterior surface. 1''. Posterior surface. 2. Mesosalpinx. 5. Fallopian tube. 6. Round ligament. 7. Ovary. 7' Hilum of ovary with vessels entering the same. 8. Graafian follicle. 9. Uterine artery. 10. Uterine veins. 11. Cellular tissue at the base of the broad ligament. 12. Ureter. (TESTUT.)

ity. In the adult virgin it may be stated to be 4 cm. in length, 2 cm. in breadth, and 1 cm. in thickness. Its weight is 8.5 grammes. In the parous woman it is diminished in both weight and volume by about 30 per cent. The ovary may be described as having two surfaces, two borders, and two extremities. Sections, longitudinal and transverse, show it to be irregularly ovoid. One surface is the flatter, one border the straighter, and extremity the narrower. In its migration from the lumbar region, where it is developed, the ovary is arrested and drawn between the folds of the broad ligament. It may also be considered as pushed into a pouch (the *bursa ovarica*) formed in the posterior layer of the broad ligament. It is thus completely invested by peritoneum except along its straighter

border. This border, thinner than the other, is designated the *hilum*. It is here that the vessels enter the gland and emerge from it. The ovary, thus invested, hangs in the peritoneal cavity from the posterior surface of the broad ligament. Its wider extremity is connected to the lateral pelvic wall by the ligamentum suspensorium ovarii; its narrower extremity has attached to it the ligament of the ovary.

If the fundus of the uterus be raised and the broad ligaments stretched out, the ovaries hang by their attached borders and their more convex surfaces are in contact with the ligaments. When, however, the uterus is in its usual anteverted position the ovaries are in a plane posterior to it. They lie upon the lateral pelvic walls, parallel to and 2.5 cm. or more below the plane of the inlet. Their narrower extremities point forward and inward. Moreover, they may turn upward so that the flattened surfaces come in contact with the broad ligaments and the free borders are superior to the hila. The Fallopian tube curves about

FIG. 30.



Section of the ovary. (After SCHRON.)

1. Outer covering. 1′. Attached border. 2. Central stroma. 3. Peripheral stroma. 4. Bloodvessels. 5. Graafian follicles in their earliest stage. 6, 7, 8. More advanced follicles. 9. An almost mature follicle. 9′. Follicle from which the ovum has escaped. 10. Corpus luteum.

the distal extremity of the corresponding ovary, and the fimbria ovarica is applied to the more convex border. The pavilion falls below the level of the ovary, but presents toward it.

Each ovary lies in a fossa bounded above by the external iliac artery and below by the ureter. The left may be in contact internally, with the sigmoid flexure of the colon, and the right with a coil of small intestine.

The peritoneal covering of the ovary is so far modified in character as to have led some histologists to class it with the mucous rather than with the serous membranes. It does not present the glistening appearance of peritoneum generally, and minute examination reveals that it is covered with epithelial rather than endothelial cells. The cells are of the columnar variety. They were supposed by Waldeyer to be the parent cells of the ova, whence the name "germinal epithelium," applied to them. After puberty the surface of the ovary is uneven, the unevenness being occasioned by the presence of unruptured Graafian follicles and of the scars of those which have ruptured and discharged their contents. This is especially true of the more convex surface. In old age the entire surface of the ovary becomes smooth.

If a section be made through the gland its stroma will be found to consist of a core of loose connective tissue about which are arranged zones of connective tissue of varying density. The peripheral zone is dense, though thin. It is of a grayish color, which has obtained for it the name *tunica albuginea ovarii*. It is inseparable from the subjacent tissue, and is in no sense a distinct envelope. Underlying the tunica albuginea is the *zona parenchymatosa* or *cortical zone*. This zone may be subdivided into two layers. The superficial layer is the denser of the two. In it are embedded undeveloped Graafian follicles to the estimated number (for each ovary) of thirty thousand or more. The deeper layer of the cortical zone is less dense than the superficial. It is very vascular and is of a reddish color. It is separately designated the *zona vasculosa*.

Bands of fibrous tissue radiate from the hilum throughout the stroma of the ovary. Into the zona vasculosa unstriped muscular tissue may be traced from the broad ligament of the uterus.

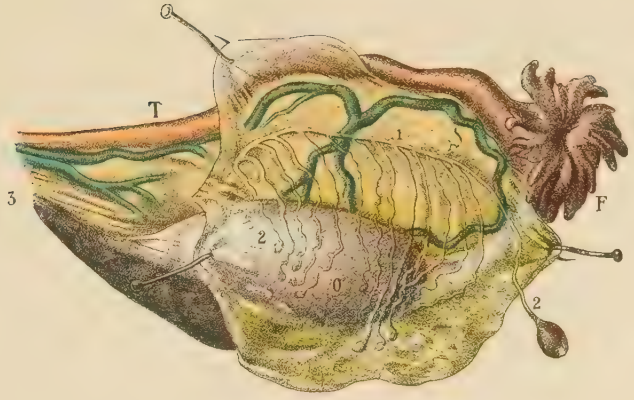
The Graafian Follicle. The *Graafian follicle* or *ovisac* as it develops sinks into the zona vasculosa, but owing to its becoming more and more distended with fluid, at maturity it approaches the surface of the ovary. Just prior to its rupture the ovisac presents the following characteristics. It is from 1 mm. to 5 mm. in diameter. It possesses a thin, fibrous envelope continuous, apparently, with the stroma of the ovary. This envelope sustains bloodvessels and supports a capillary network of the same. That part of the envelope projecting upon the surface of the ovary is most vascular, and it is here that the future rupture is destined to take place. This point is called the *stigma*. The investing membrane of the follicle is lined with several layers of columnar or cuboidal epithelial cells. This epithelial lining has been named the *membrana granulosa*. At some point, usually opposite the stigma, the cells of the membrana granulosa are greatly multiplied, constituting the *discus proligerus*. In the cells of the discus proligerus is embedded the *ovum*. On pricking the follicle a drop of clear serum exudes. At maturity, by the accumulation of this fluid and the consequent distention of the follicle, the investing membrane is ruptured at stigma and the ovum is discharged upon the surface of the ovary.

The Corpus Luteum. After its rupture the Graafian follicle undergoes certain changes resulting in what may be considered a scar. This is formed by the infolding of the collapsed cell-wall, and it presents a fluted appearance. It is of a yellow color, whence its name, the *corpus luteum*. If the discharged ovum undergoes impregnation the development of the corpus luteum is of longer duration, and results in a larger cicatrix than when pregnancy does not occur.

The Parovarium. Lying between the folds of the mesosalpinx is the *parovarium*, *epoöphoron*, or *organ of Rosenmüller*. It is a fœtal relic and functionless, but analogous to the epididymis in the male. It consists of a number of convoluted tubules. These converge toward the ovary, to the hilum of which they are attached near its distal extremity. They spread out, fan-shaped, within the mesosalpinx and open into a duct which lies parallel with the Fallopian tube and nearer to it than to the ovary. The duct may be continued to the uterus, though its lumen becomes closed before it reaches that organ. It may present cystic enlargements or cyst-like bodies may be suspended from it by elongated pedicles.

PLATE VII.

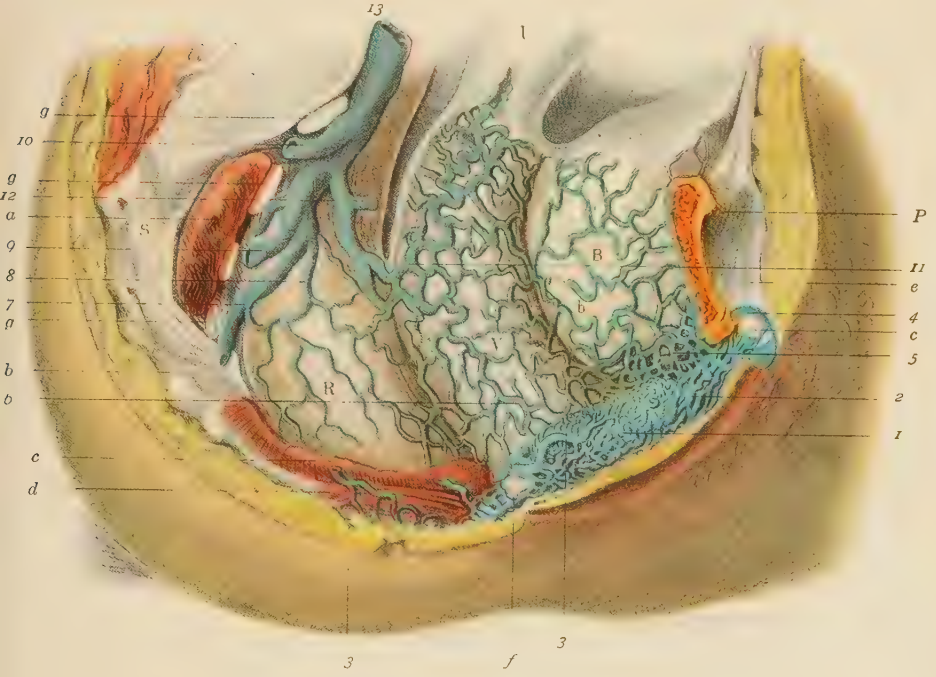
FIG. 1.



Mesosalpinx Laid Open, showing the Parovarium or Organ of Rosenmüller. (Savage.)

T, Fallopian tube; *F*, fimbriated extremity of same; *O*, ovary; 1, remnant of Wolffian duct; 2, 2, remnants of the cecal tubes of the Wolffian bodies; 3, ovarian ligament.

FIG. 2.



Venous Plexuses of the Clitoris, Bulb, Vagina, Bladder, and Rectum, seen from the side. (Savage.)

B, bladder partly inflated and with (*b*) ureter cut; *V*, vagina; *P*, section of pubis; *c*, clitoris; *U*, uterus; *R*, rectum; *S*, sacrum; 1, veins of the bulb; 2, veins of pars intermedia; 3, efferent veins to pubic vein; 4, dorsal vein of clitoris; 5, urethral plexus; 6, vaginal plexus; 7 to 12, branches uniting to form 13, the internal iliac vein; *a*, pyriformis muscle; *b*, great sciatic ligament; *c*, levator ani muscle; *d*, coccygeus muscle; *e*, suspensory ligament of clitoris; *f*, bulbovaginal gland; *g*, *g*, *g*, roots of sacral plexus.

The *paroöphoron* consists of several detached tubules lying internally to and below the epoöphoron (Quain). It corresponds to the organ of Giraldes in the male. (Plate VII, Fig. 1.)

The Ligaments of the Ovaries. The ligaments of the ovaries are dense fibrous bands about 4 cm. in length, and receiving muscular fibres from the external stratum of the uterus. They connect the ovaries and the uterus. They are attached to the narrower extremities of the ovaries and to the uterus just below and posterior to the attachments of the Fallopian tubes.

The Round Ligaments of the Uterus. The round ligaments of the uterus are fibrous bands or cords containing bloodvessels. They pass from the uterus, between the folds of the broad ligaments, to and through the inguinal canals. They are attached to the uterus just anterior to the attachments of the Fallopian tubes. Between the folds of the broad ligaments they each receive an investment of muscular tissue from the external stratum of the uterus.

In the usual anteverted position of the uterus, the round ligaments curve outward, upward, and forward, in front of the ovaries, to reach the sides of the pelvis. Here they cross the external iliac arteries. In this part of their course they pull forward the anterior layers of the broad ligaments, thus appearing to be invested by peritoneum. Leaving the broad ligaments they curve forward and inward to the internal abdominal rings, through which they enter the inguinal canals. At the internal abdominal rings they have the deep epigastric arteries to their outer sides. Traversing the inguinal canals they emerge from the external abdominal rings and break up into strands and are lost in the areolar tissue of the mons pubis and of the labia majora.

Though the round ligaments may be well defined throughout their entire length, they are, as a rule, difficult of demonstration in the lower parts of the inguinal canals, where they frequently consist of fascial expansions only.

In the infant the round ligament is invested throughout with peritoneum. This forms a tubular sheath about it, extending well into the inguinal canal. It corresponds with the processus vaginalis in the male, and is known as the *canal of Nuck*. As a rule, it is obliterated in the adult below the internal ring. However, it not only may persist, but may extend beyond the external ring, and into the labium majus.

The entire length of the round ligament is from 10 cm. to 13 cm. Its diameter near the uterus is about 4 mm. and for the rest of its length a little less.

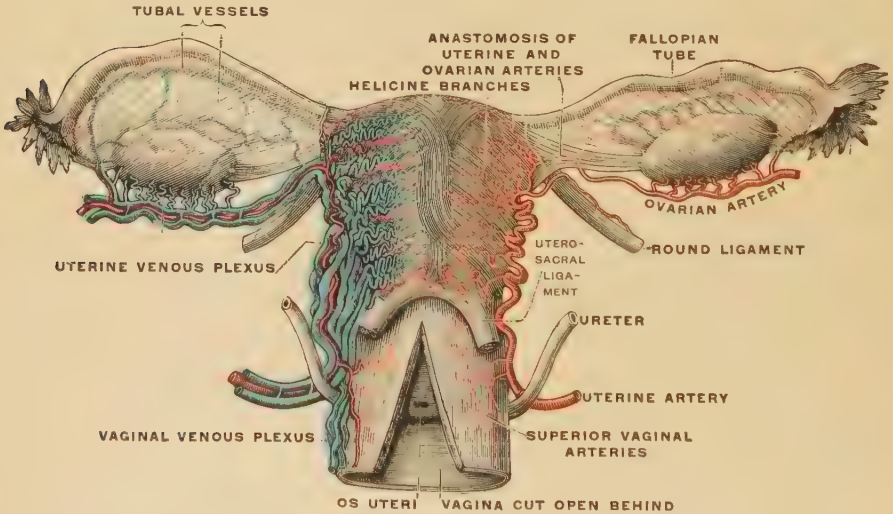
The Connective Tissue of the Pelvis. The spaces between the intrapelvic structures which have been described are filled in with connective tissue. This serves to unite and support the various organs and to sustain the vessels which supply them. It is dense and firm at the vesico-vaginal and at the recto-vaginal septum. Between the broad ligaments and beneath the utero-sacral bands it is reinforced by muscular tissue, as has already been described. In other situations, as between the pubic bones and the bladder, about the cervix uteri, between the rectum and the sacrum, and at the bases of the broad ligaments, it is loose and areolar in character.

Blood- and Nerve-supply of the Pelvic Floor. With the exception of the

ovarian arteries all vessels supplying blood to the pelvic structures are branches of the internal iliac arteries. The anterior trunk of the internal iliac artery on each side lies upon the pyriformis muscle. At the lower border of this muscle it divides into the sciatic and internal pudic arteries. Both of these arteries escape from the pelvis through the greater sciatic foramen below the pyriformis. The internal pudic artery, winding about the ischiatic spine, returns to the pelvis through the lesser sciatic foramen and supplies the genitalia.

The arteries and nerves supplying the genitalia and the pelvic floor in the female correspond with those distributed to analogous structures in the male. Their distribution has already been sufficiently discussed. Attention should be called, however, to the statement of Ranney, that the superficial vessels and nerves perforate the deep layer of the superficial fascia in the female, though not in the male. The fact should be mentioned, also, that the superficial artery is larger than its analogue in the male, and that it is sometimes called the *vulvar* artery. In this same connection it should be borne in mind that the anterior layer of the triangular ligament is perforated by the vessels which correspond with the dorsal arteries and vein of the penis, and with the arteries to the corpora cavernosa and to the bulb in the male.

FIG. 31.

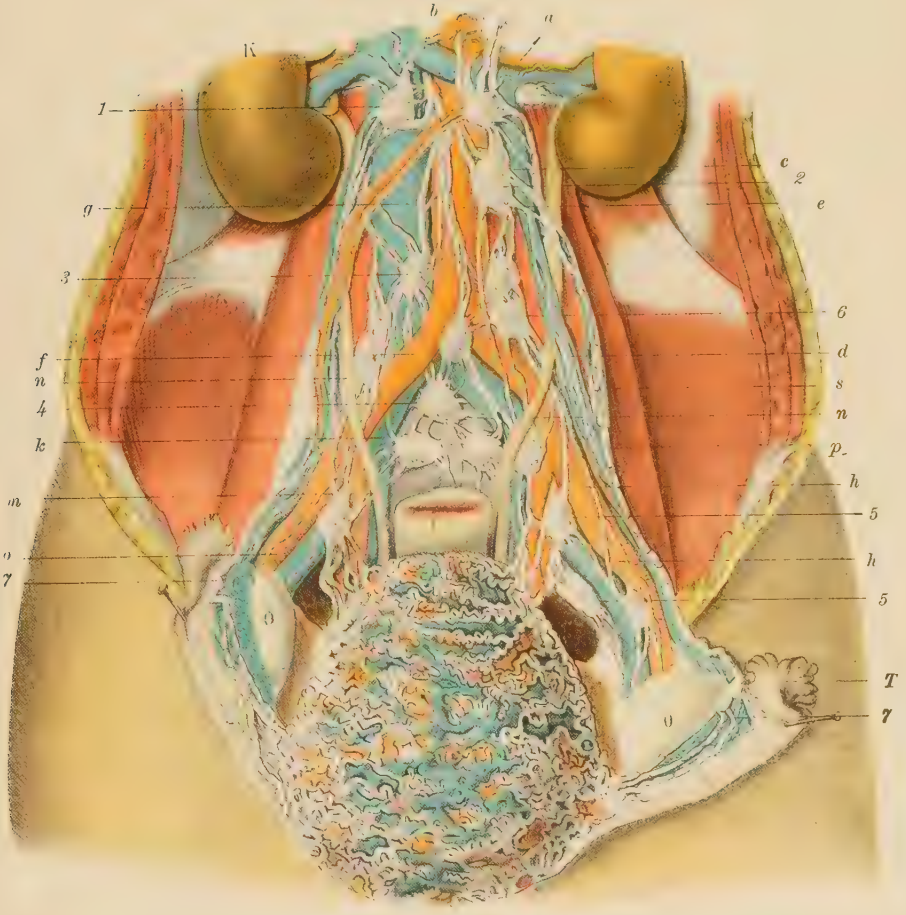


Bloodvessels of the uterus and its appendages. (TESTUT.)

The vascular and nervous supply of the bladder and of the rectum is practically identical in both sexes.

The Vessels and Nerves of the Vagina. The vagina gets its principal blood-supply from the vaginal arteries. These are analogous to the inferior vesical in the male. They may arise directly from the parent trunks or from the uterine arteries. Reaching the sides of the vagina they anastomose with the pudic arteries near the ostium, and with the uterine arteries near the cervix uteri. The blood is returned by veins which accompany the arteries. First, however, the veins form rich plexuses in the vaginal walls both internally and externally to the mus-

PLATE VIII.



Lymphatics of the Gravid Uterus and Appendages. (Savage.)

1, 2, superior lumbar glands; 3, inferior lumbar glands; 4, sacral glands; 5, external iliac glands; 6, common iliac glands; 7, ovarian plexus; *a*, left renal artery; *b*, left renal vein; *c*, left ovarian vein; *d*, left ovarian artery; *e*, aorta; *f*, common iliac artery; *g*, ascending vena cava; *h*, external iliac artery; *k*, common iliac vein; *m*, *n*, ureters; *o*, right common iliac artery; *p*, iliacus muscle; *s*, psoas magnus muscle; *O*, ovary reversed to show lymphatics; *K*, kidney; *T*, Fallopian tube.

cular coat. (Plate VII', Fig. 2.) The veins are devoid of valves and communicate freely with the pudendal, vesical, and hemorrhoidal plexuses, and with the plexuses between the folds of the broad ligaments. The plexus external to the muscular coat consists of large vessels. These veins are surrounded by unstriped muscular fibres. Thus is formed a pseudo-erectile tissue.

Along the veins of the vagina, and accompanying them, are lymphatic canals and spaces. Those of the lower third of the vagina communicate with the lymphatics of the vulva, and are drained by the inguinal glands. Those of the upper two-thirds join the lymphatics of the cervix and empty into a chain of glands which accompany the internal iliac arteries.

The nerve-supply of the vagina is derived, in the main, from the inferior hypogastric plexuses. Branches of the internal pudic nerve are distributed to its lower part.

The Vessels of the Uterus. The uterine artery, upon each side, is given off from the anterior trunk of the internal iliac either above the vaginal or in common with it. It enters the base of the broad ligament and descends between the folds to the roof of the vaginal fornix. After supplying the cervix it takes an upward turn and reaches the side of the uterus at about the level of the os internum. Proceeding upward it anastomoses freely at the fundus with the ovarian artery. Throughout its course along the body of the uterus it gives off numerous branches which, anastomosing with corresponding branches from the opposite side, encircle the organ. The parent trunks and their branches, because very tortuous in their courses, are spoken of as "the curling arteries of the uterus." One branch, larger than the others, at the level of the isthmus, is known as the *circular* artery. It may sometimes be found below the level of the isthmus.

The fundus of the uterus is supplied by terminal branches of the ovarian arteries.

The arteries of the uterus pierce its muscular walls and terminate in capillaries within the mucous membrane.

The veins are large and abundant in the middle muscular stratum. Their coats being intimately united to surrounding tissues render them always patulous. Rouget describes a direct communication between them and the arteries without capillary intervention. This, if true, would constitute the uterus an erectile organ. Under the peritoneal covering of the uterus the veins form an intricate plexus which communicates freely with that in the vaginal walls and with that between the folds of each broad ligament. The plexuses thus formed at the sides of the fornix have been named the *utero-vaginal plexuses.* They are of especial interest because traversed by the ureters, which, entering the pelvis, cross the iliac vessels from without inward and pass under the uterine arteries. The ureters here are about 15 mm. external to the cervix. Having traversed the plexuses above described, they curve inward in close contact with the anterior vaginal wall and enter the bladder at the lateral angles of the trigone.

Within the mucous membrane of the uterus are lymph-spaces. About the vessels of its muscular walls are perivascular sheaths forming lymph-sinuses. Beneath the peritoneal covering is a rich plexus of lymphatic vessels. (Plate VIII.) The lymph from the body of the uterus ulti-

mately reaches the lumbar glands; that from the cervix enters the iliac chain.

The Vessels of the Fallopian Tubes. The ovarian arteries arise from the aorta and descend to the lateral pelvic walls. Each enters the broad ligament of its own side, and is guided by the ligamentum infundibulo-pelvicum to the hilum or attached border of the ovary. Along this it pursues a tortuous course, and, leaving it, inclines upward and inward to reach the cornu of the uterus between the round ligament and the Fallopian tube. It gives branches to the ligament, the tube, and the ovary, and supplies the fundus of the uterus, anastomosing with the uterine artery. The isthmus and the fimbriated extremity of the tube are supplied by branches given off directly from the parent trunk. The ampulla is, for the most part, supplied by offshoots from the branches which are distributed to the ovary.

The larger subdivisions of the ovarian arteries are accompanied by veins.

The arrangement of the bloodvessels, as well as of the lymphatics, in the Fallopian tubes is similar to that in the uterus.

The Vessels of the Ovaries. The branches of the ovarian arteries which supply the ovaries are exceedingly tortuous, even to their minute subdivisions. They cover the surfaces of the ovaries and enter them at the hila. Those entering the glands form, in the zonæ vasculosæ, rich capillary networks about the ovisacs. The veins emerging at the hila enter plexuses "in which the ovaries and ovarian ligaments seem to be partly embedded" (Savage). (Plate IX., Fig. 1.) To these plexuses is sometimes applied the name of "the bulbs." Upon each side the blood from the bulb, the Fallopian tube, and the body of the uterus enters an extensive venous plexus surrounding the ovarian artery. This is the *pampiniform* (tendril-like) *plexus*, and is drained by the ovarian vein.

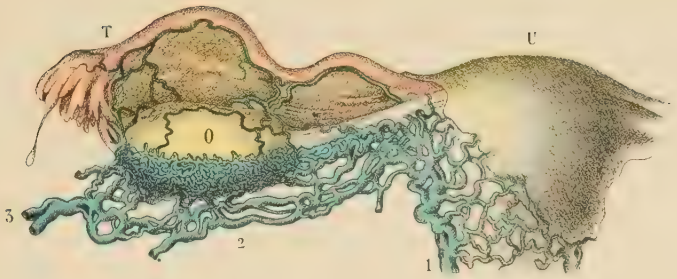
The ovaries are rich in lymphatics. The efferent vessels are joined by those from the uterus and by those from the tubes. They form plexuses within the folds of the broad ligaments, and the lymph from them enters the lumbar glands.

The Nerves of the Uterus, Tubes, and Ovaries. The uterus is supplied by branches from the inferior hypogastric plexuses of nerves, though branches from the ovarian plexus as well reach its fundus. The inferior hypogastric plexuses supply the Fallopian tubes also. The ovaries receive their nerve-supply from the ovarian plexus. The method of termination of the nerves in the ovaries is undetermined. They have been traced into the hilum, where they form a network about the vessels. Some investigators claim to have traced them to the Graafian follicles.

The Inferior Hypogastric Plexuses. The *inferior hypogastric* are also called the *pelvic* plexuses. (Plate IX., Fig. 2.) They are situated at the sides of the rectum, the bladder, and the vagina. In their distribution their branches accompany the internal iliac arteries. The plexuses are formed by filaments from the hypogastric plexus of the sympathetic joined by nerves from the sacral ganglia and branches of the second, third, and fourth sacral nerves. The nerves which supply the vagina accompany the vaginal arteries. They are derived almost entirely from such parts of the inferior hypogastric plexuses as come from the cerebro-spinal axis. The nerves which supply the vaginal fornix, the cervix

PLATE IX.

FIG. 1.



Bulb of the Ovary and its Venous Communications. (Savage.)

O, ovary; *T*, Fallopian tube; *U*, uterus; 1, uterine vein and plexus; 2, subovarian venus plexus; 3, commencement of ovarian vein.

FIG. 2.

Nerves of the Pelvic Organs. (Savage.)

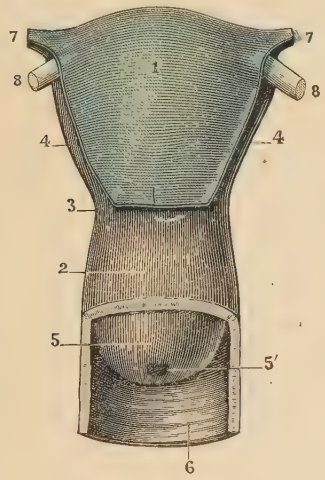
R, rectum; *U*, uterus; *B*, bladder; *P*, pubis; *S*, section of the ilium; *D*, transversus perinei muscle; 1, hypogastric plexus; 2, rectal plexus; 3, a lumbar ganglion; 4, 4, ovarian plexus; 5, branch from third and fourth sacral nerves; 6, 7, right inferior hypogastric plexus; 8, uterine filaments; 9, vesical plexus; 10, great sciatic nerve; 11, levator ani branch from fourth sacral nerve; 12, pudic nerve; 13, distribution of pudic nerve to clitoris.

uteri, the body of the uterus, and the Fallopian tubes accompany the uterine arteries, and upon them may be demonstrated ganglionic enlargements.

The Ovarian Plexus. The *ovarian plexus* is derived from the renal and aortic plexuses of the sympathetic system. It surrounds the ovarian arteries, and in its distribution accompanies its branches.

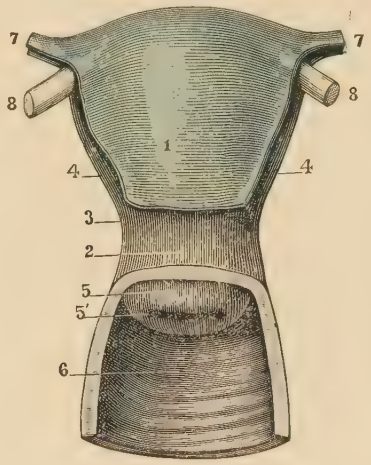
The Uterus. The *uterus* is a pyriform body, but it differs in form and dimensions in non-parous and in parous women. That of the adult virgin when removed from the body weighs between 32 grammes and 42 grammes. Its entire length is about 7.5 cm. Near the centre of its length it presents a constriction, the *isthmus*. This marks the division of the organ into the *body* and *cervix*. The superior portion is the *body* and the inferior the *neck* or *cervix*. Somewhat less than three-fifths of the

FIG. 32.



The uterus of a virgin seen anteriorly.

FIG. 33.



The uterus of a multiparous woman seen anteriorly.

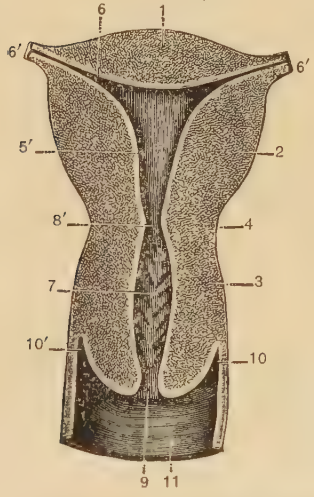
1. The body of the uterus covered with peritoneum. 2. The extravaginal portion of the cervix. 3. The isthmus. 4. The border of the uterus. 5. The intravaginal portion of the cervix. 5′. The os externum. 6. The posterior wall of the vagina. 7. The uterine extremity of the Fallopian tube. 8. The round ligament. (TESTUT.)

entire length of the uterus belongs to the body. The sagittal diameter at the centre of the body is 2.5 cm. and that at the centre of the cervix very little less. The greatest transverse diameter of the body is about 4.5 cm. and that of the cervix 2.5 cm. The diameters at the isthmus are somewhat less than those of the cervix. The cervical segment is conical in form, and its diameters are shortest at its free extremity. The posterior surface of the body of the uterus is markedly convex, the lateral surface slightly so, and the anterior surface almost plane. The superior extremity of the uterus is designated the *fundus*. It is convex both transversely and antero-posteriorly. The lateral angles are known as *cornua*, and here are attached the Fallopian tubes, the round ligaments, and the ligaments of the ovaries. The cervix uteri is also slightly convex vertically. This is least noticeable over its anterior surface, because the sulcus between

the body and the neck is there least marked. The posterior surface is rendered more convex by the bevelling off, or thinning out, of the posterior lip. The free extremity of the cervix presents a small rounded opening—the *os tincæ* or *external os*. After child-bearing this is converted into a transverse slit. The circumference of the os tincæ is divided into an *anterior* and a *posterior lip*. The anterior is the thicker and apparently the more prominent.

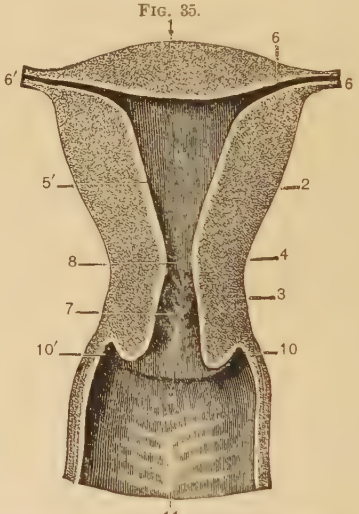
The uterus is a hollow organ. Its walls, however, are in actual contact. In sagittal section its cavity is seen to extend from the os tincæ to within 2 cm. of the free superior surface of the fundus. Its most constricted part is at the junction of the body with the cervix. Coronal section shows the cavity of the cervix to be fusiform and that of the body triangular. The triangular shape of the outline of the body

FIG. 34.



Coronal section of the uterus of a nulliparous woman.

FIG. 35.



Coronal section of the uterus of a multiparous woman.

1. Fundus. 2. Lateral walls of the body. 3. Cervix. 4. Isthmus. 5. Cavity of the body. 5′. Internal wall of the body. 6. Cornu. 6′. Opening of the Fallopian tube. 7. Arbor vitæ. 8. Os internum. 9. Os externum. 10, 10′. Lateral fornices. 11. Posterior vaginal wall. (TESTUT.)

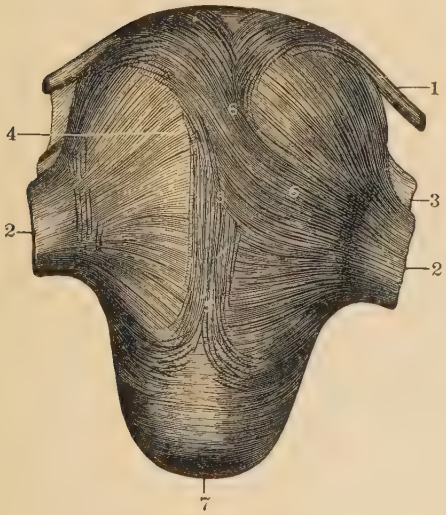
cavity is less marked, however, in parous women. The constriction between the cavities of the cervix and of the body is designated the *os internum*. Under normal conditions in the non-gravid uterus it barely admits a probe 3 mm. in diameter. The os internum is situated at the inferior angle of the cavity of the body of the uterus. Into the lateral angles open the Fallopian tubes. It has already been stated that the cervix uteri projects into the upper and anterior part of the vaginal vault. The attachment of the vagina to it has led to its division into a supravaginal and an infravaginal portion. This attachment of the vagina to the cervix is such as to render these portions of about the same length anteriorly. Posteriorly, however, the supravaginal portion is somewhat the longer. The anterior lip of the cervix is, therefore, apparently the longer of the two.

The cervix of the virgin is conical in shape and is firm to the touch. That of the parous woman is longer and more nearly cylindrical, and the os tincæ is patulous and irregular in outline.

As a result of childbearing the body of the uterus is somewhat enlarged, and the difference between its sagittal and its transverse diameters is diminished. Its cavity is more capacious and less markedly triangular in outline. The whole organ is so changed that the body is relatively longer as compared with the cervix. Their lengths now are a little more than 2.5 cm. for the cervix, and a little more than 5 cm. for the body. The weight of the organ is increased by about 50 per cent.

The uterus is essentially a muscular organ. It is lined with mu-

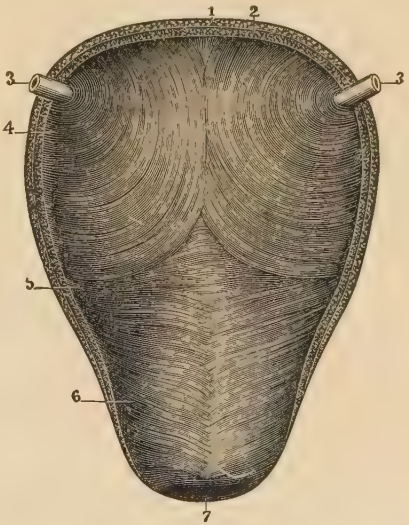
FIG. 36.



External muscular layer of the uterus, seen upon the anterior surface of the organ.

1. Tube. 2. Origin of round ligament. 3. Origin of ovarian ligament. 4. Transverse fibres. 5. Longitudinal fibres forming the anterior branch of the ensiform fascicle. 6. Fascicle in Z-shape. 7. External orifice of the cervix. (TESTUT.)

FIG. 37.



Internal muscular layer of the uterus, seen after removal of the external and middle layers.

1. Section of external muscular layer. 2. Section of middle muscular layer. 3. Fallopian tubes. 4, 5, 6. Variously disposed fibres. 7. Os externum. (TESTUT.)

cous membrane and partially invested with peritoneum. Its walls are of an average thickness of 1 cm. Though the fibres interlace in such a manner as to be inseperable except in the gravid uterus, anatomists are almost universally agreed that they are arranged in three distinct layers. They are of the unstriated or involuntary variety, and have interposed between them connective-tissue cells. The *external* muscular layer or stratum is exceedingly thin, and can be demonstrated upon such parts of the uterus only as are covered by the peritoneum, and with this it is intimately connected. The fibres of this layer pass from the anterior and the posterior surfaces and from the fundus upon the Fallopian tubes, the round and the ovarian ligaments, and accompany such parts of the peritoneum as form the broad and the utero-sacral ligaments. The *internal* muscular layer is so intimately connected with the mucous mem-

brane as to be, by some, described with it, for, except in the cervix, there exists in the uterus no submucosa. The fibres of this layer have a circular arrangement. They are augmented at the orifice of the Fallopian tubes, at the os externum, and at the os internum. Those at the os internum are considered as forming a sphincter muscle. The *middle* muscular layer constitutes much the greatest part of the structure of the uterus, and is continuous with the muscular coat of the vagina. It is of an average thickness of 6 mm. The fibres have no definite arrangement, but interlace in every direction. They develope in size enormously during gestation. The stratum is exceedingly vascular. The coats of the vessels are so intimately held to the muscular fibres by connective tissue that the veins remain patulous on cross section.

The walls of the uterus are thickest over the fundus and at the sides of the organ. They diminish in thickness at the isthmus and as the Fallopian tubes are approached.

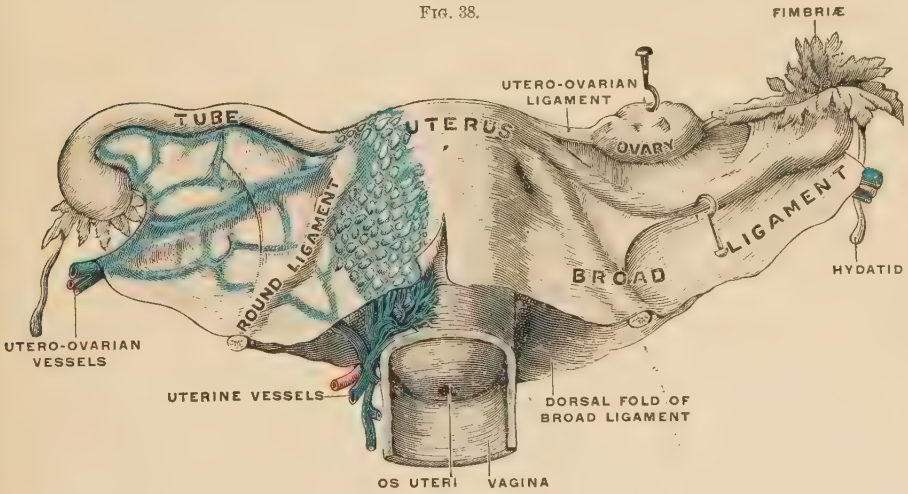
The cavity of the uterus is lined throughout with mucous membrane. This is continuous with that lining the Fallopian tubes, with the external mucosa of the infravaginal part of the cervix, and with that lining the vagina. It differs in thickness and character in different parts of the organ. Its average thickness is 1 mm. Over the central part of the cavity of the body it is 2 mm. thick, and 3 mm. in the cervix. In this later location, as has already been intimated, it is more loosely attached to the underlying structure. Contrary to the arrangement in most of the hollow viscera, and probably by reason of its firmer attachment to the muscular wall, the mucous membrane of the body of the uterus is not thrown into folds or rugæ, except, possibly, at the cornua. It is of a dark red-color. That of the cervix contrasts decidedly with that of the body. The former is lighter in color, is firmer to the touch, and is thrown into plicæ or folds. It should also be noted that the transition from the mucosa of the body to that of the cervix is not gradual but abrupt. The line of demarcation is at the os internum. To a peculiar arborescent arrangement of the folds of mucous membrane in the cervix uteri has been given the name *arbor vitæ uterini* (*plicæ palmatæ*). On the anterior and on the posterior walls of this cavity is a median longitudinal ridge from which the plicæ extend upward and outward. As in the vagina, the markings upon the anterior wall are the more distinct, and parturition has the effect of partially obliterating them upon both walls. It has been claimed by Guyon that the ridges upon the one wall are so arranged as to fit into the depressions upon the other, thus more completely occluding the cervical canal.

Thickly scattered over the surface of the cavity of the body of the uterus are the openings of glands. The glands were originally infoldings of the mucous membrane, but have been developed into distinct tubules, frequently descending into the underlying muscular structure. They may be simple follicles or have branching extremities. The ducts may be straight, or may take a spiral course, but their axes are always obliquely inclined to the intra-uterine surface. The walls of the uterine glands consist of prismatic or columnar epithelium, supported upon a delicate basement membrane. The cells, as well as those of the surface, which are also of the same variety, are held together by connective tissue,

and the connective tissue supports the vessels of the mucous membrane. The epithelium of the body of the uterus is provided with cilia. They are difficult of demonstration, since they are easily detached and soon thereafter lose their characteristic motion. The direction in which they propel is downward.

The mucous membrane of the cervical canal is thicker and firmer than that of the body, but is less intimately attached to the subjacent tissue. Differences which relate to the circulation will be considered hereafter. The presence of papillæ, though claimed by Henle, is denied by Klein. The glands are of the racemose variety. They are lined by cuboidal, non-ciliated epithelium. When their ducts are obstructed the imprisoned secretion forms cyst-like bodies upon the surface of the membrane. These bodies have been designated the *ovula of Naboth*. They are pathological in character. The surface cells are of the columnar variety to within a few lines of the os externum. Here they change, by a dentated border,

FIG. 38.



The uterus and adnexa viewed from the front. (TESTUT.)

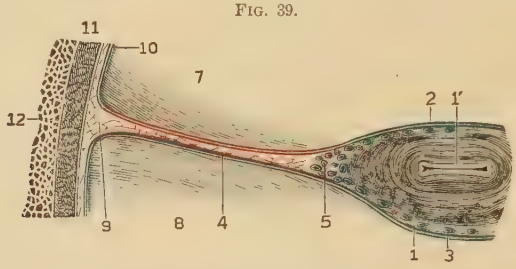
to the variety covering the intravaginal surface of the cervix. The cells upon the summits of the plicæ are ciliated, while those in the furrows are devoid of these processes (Klein). The plicæ are absent in the lower sixth of the canal. This has led to the erroneous statement that the epithelium of the upper part of the cervical canal is ciliated, while that of the lower part is not.

The mucous membrane covering the intravaginal surface of the cervix uteri is smooth, closely adherent to the subjacent tissue, and, according to Quain, is destitute of glands. It is covered with pavement epithelium.

Ligaments of the Uterus. The uterus, during its development, may be considered as pushing its fundus upward beneath the peritoneal bag, so that this membrane partly covers its anterior and its posterior surfaces. This extensive serous membrane is reflected from the bladder upon the anterior surface of the uterus at about the level of the isthmus. It passes upward over the fundus and downward over the posterior wall to the vaginal attachment. It is intimately connected with the external

muscular stratum of the body of the uterus, so much so as to have led anatomists to describe the organ as having a peritoneal coat. The anterior wall of the cervix above the vaginal attachment and below the isthmus is connected to the bladder by fibro-cellular tissue.

FIG. 39.

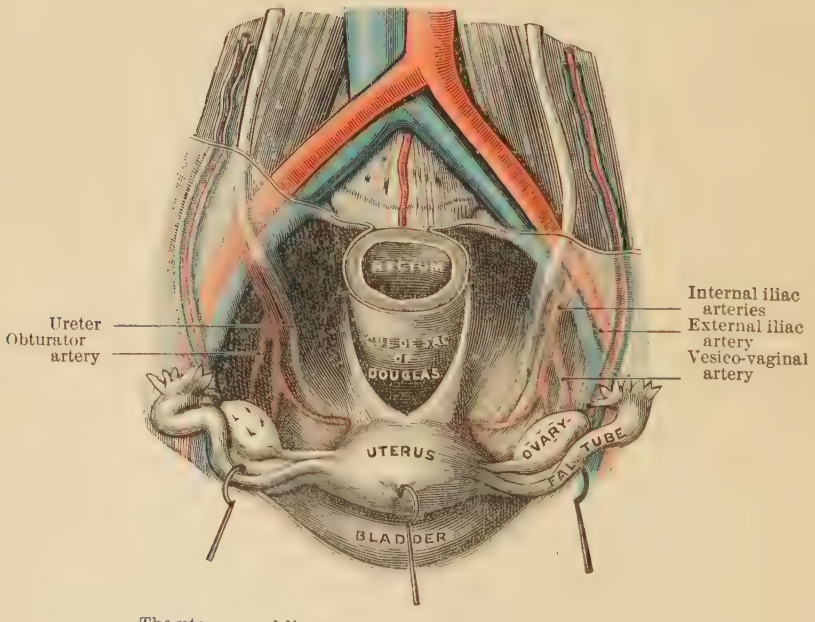


Horizontal section through the body of the uterus and the base of the right broad ligament.

1. Body of the uterus. 1'. Cavity of the uterus. 2. Peritoneum covering the posterior wall of the uterus. 3. Peritoneum covering the anterior wall of the uterus. 4. Broad ligament. 5. Uterine artery. 7. Post-uterine cavity. 8. Pre-uterine cavity. 9. Subperitoneal areolar tissue. 10. Parietal peritoneum. 11. Obturator internus muscle. 12. Ischium. (TESTUT.)

The peritoneum covering the uterus extends outward from the whole length of each side of the body of that organ to the pelvic wall. The attachment to the pelvis is "from the great sciatic notch downward

FIG. 40.



The utero-sacral ligaments or folds of Douglas. (TESTUT.)

along the obturator foramen to the level of the spine of the ischium." These two folds of peritoneum, one upon each side, constitute the *broad ligaments of the uterus*. Each ligament consists of two layers of peritoneum reinforced by subperitoneal areolar tissue and by muscular fibres

from the external stratum of the uterus. The broad ligaments together with the uterus constitute a partition by which the pelvic cavity is divided into an anterior and a posterior recess, the deepest parts of which are the vesico-uterine pouch and the cul-de-sac of Douglas, respectively.

The vesico-uterine folds constitute the *anterior ligaments of the uterus* or the *vesico-uterine ligaments*. The recto-vaginal folds form the cul-de-sac of Douglas and constitute the *posterior* ligaments of the uterus. Bounding the cul-de-sac on the sides are crescentic folds of peritoneum. They extend from the upper part of the cervix uteri, or a little higher in parous women, to the rectum and past it to the second sacral vertebra. They are known as the *utero-sacral ligaments*. Webster calls attention to the fact that they run backward from the uterus in a direction practically parallel with the vagina. Like the broad ligaments, the utero-sacral ligaments are reinforced by fibrous and muscular elements.

THE MAMMARY GLANDS.

The mammary glands exist in males and in females alike. There is little or no difference between them in the sexes during infancy and childhood. As the age of puberty approaches the gland of the female undergoes a rapid and characteristic development. That of the male remains rudimentary throughout life, although rare exceptions to this rule exist. The location of the mammæ upon the anterior chest-wall has obtained for them the common name of the *breasts*. Embryology teaches that the glandular structure is a modification of the sebaceous glands. Supernumerary mammæ may, therefore, occur as accidents of development. When existing they are usually small and located upon the chest or in the axillæ. They may, however, attain considerable size and may be formed upon other parts of the body.

The female breasts differ in size and in appearance in different individuals. These differences depend upon age, race, condition in life nutrition, and the activity or quiescence of the gland. In the same person, the left breast is generally somewhat larger than the right.

In a well-developed, non-parous white woman the breasts appear as hemispherical or conoidal masses, one upon each side. In the negress they are pendulous. They are firm to the touch. Each is about 5 cm. in thickness. The circumference of its base is slightly elliptical, the major axis being directed upward and outward toward the axilla. Internally it overlaps the border of the sternum. Externally it is bounded by the mid-axillary line. Vertically it is bounded above by the second or third rib, and below by the sixth or seventh rib. Its weight averages 175 grammes.

At the most prominent part of the breast is the *Nipple* or *mammilla*. It usually appears as a conical wart-like excrescence. Sometimes it is flattened and ill-defined, or its side may be marked by a depression. Surrounding the nipple is a zone of modified integument. It is designated the *areola*. The areola is about 2.5 cm. in width. The color of the nipple and of the areola varies with the complexion of the individual. In blondes they are a rosy pink; in brunettes a delicate brown. Though the nipple is slightly below the centre of the breast, it points upward and outward when the body is in the upright position.

This is due to the sagging of the base of the gland. The nipple is then about opposite the fourth intercostal space.

The skin of the nipple and of the areola differs from that of the rest of the breast and from skin generally. That of the nipple is tough and leathery. It is beset with numerous sensitive papillæ, is wrinkled from the presence within it of unstriped muscular tissue, is supplied with large sebaceous glands, is destitute of hairs or of sweat-glands, and is perforated near its centre by the openings of the milk-ducts. The skin of the areola

FIG. 41.

Breast of virgin, showing pink areola and position of gland. (DENNIS.)

is delicate in texture. It is abundantly supplied with sudoriparous glands. Hair follicles are present. The sebaceous glands are markedly developed. They open upon little elevations which give to the areola a tuberculated appearance. Near the base of the nipple the ducts of a variable number of accessory milk-glands open upon the areola.

As the first pregnancy advances the breasts increase in size. The

PLATE X.

Breast of Dark Brunette, Near Term.
From Life.

Breast of Blonde in Later Months of Pregnancy.
From Life

nipples also enlarge and become cylindrical in shape. The areolæ widen and undergo deeper pigmentation. The sebaceous glands of the areolæ become more active. The elevations marking their ducts become more prominent. They are now known as the glands of Montgomery. During lactation the breast may weigh, according to Testut, as much as 500 grammes.

After lactation the breasts decrease in size, but do not regain their former appearance. They lose firmness and become soft and pendulous. The nipples remain prominent and the areolæ wide. In blondes

FIG. 42.

Breast of woman who has been pregnant, showing pigmented areola and position of gland. (DENNIS.)

the areola may assume their original color, but in brunettes they remain deeply pigmented.

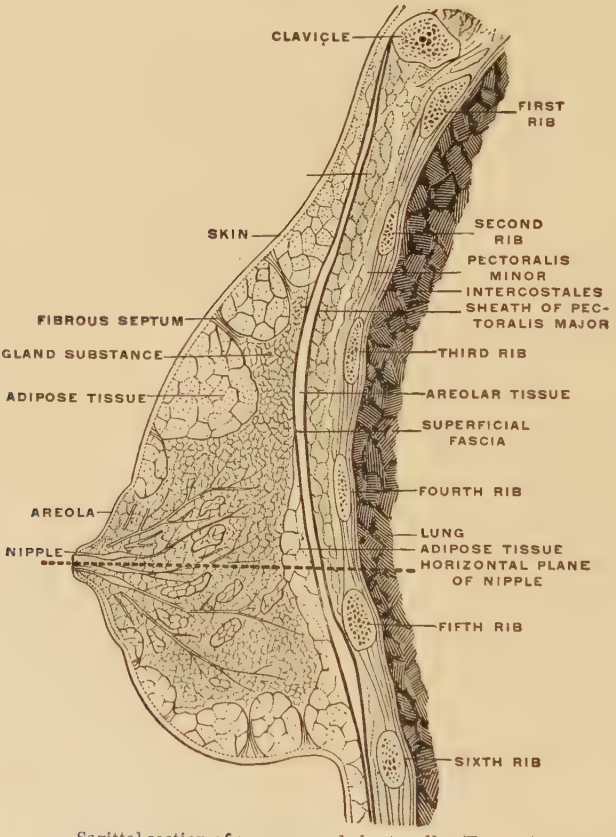
The mammary gland is made up of from twelve to twenty lobes, each of which may be considered a distinct gland. The lobes are pyramidal in form, their apices being represented by ducts which discharge at the nipple. They are encapsulated by a fascia which sends processes between them and between the lobules of which they are composed. The capsule of the mammary gland is concave toward the chest-wall. It is attached to the fascia of the underlying muscles by connective tisues bands. These may enclose lymph-spaces, the so-called *submammary*

bursæ. Occasionally little masses of glandular tissue perforating the capsule lie embedded in the pectoral muscle.

Internally the breasts lie upon the pectoralis major muscles; externally and below they overlap the interdigitations of the serratus magnus with the external oblique muscles; externally and above they are separated from the serratus magnus muscles by the axillary fasciæ.

The convex surface of the capsule enclosing the lobes is uneven. It sends processes to the overlying skin known as the *ligaments of Cooper*.

FIG. 43.



Sagittal section of mamma and chest-wall. (TESTUT.)

Except beneath the nipple and the areola the superficial fascia of the breast contains fat. Fat is also found in the fascia between the lobes. Upon the quantity of fat depends in a great measure the size of the breasts. Beside the lobes constituting the gland proper, minute glandular bodies may be found near the base of the nipple. They are the so-called *accessory glands*. They are from five to twelve in number. Their ducts may open independently upon the surface of the areola or may open into the principal ducts traversing the nipple.

The glandular tissue of the breast may be distinguished from the surrounding fat by it pinkish color and its firmer consistence. Each lobe is

a compound racemose gland, and consists of a number of lobules. The lobules are surrounded and supported by fibrous connective tissue derived from the interlobular septa. Each lobule consists of ultimate *acini* or *alveoli* arranged about a central canal. The canals unite to form the interlobular ducts. The interlobular ducts unite to form the principal duct of the lobe. This is the *tubulus lactiferi*, or *galactophorous duct.*

Before lactation and during subsequent periods of functional inactivity the acini are small and undeveloped. They consist of a membrane (*membrana propria*) enclosing a mass of granular polyhedral cells. During pregnancy they enlarge, and the central cells soften. At the commencement of lactation the central cells are discharged as colostrum corpuscles. The peripheral cells are of the short columnar variety and line the membrana propria. The walls of the ducts are of areolar tissue, in which elastic fibres are disposed in both a circular and a longitudinal

FIG. 44.

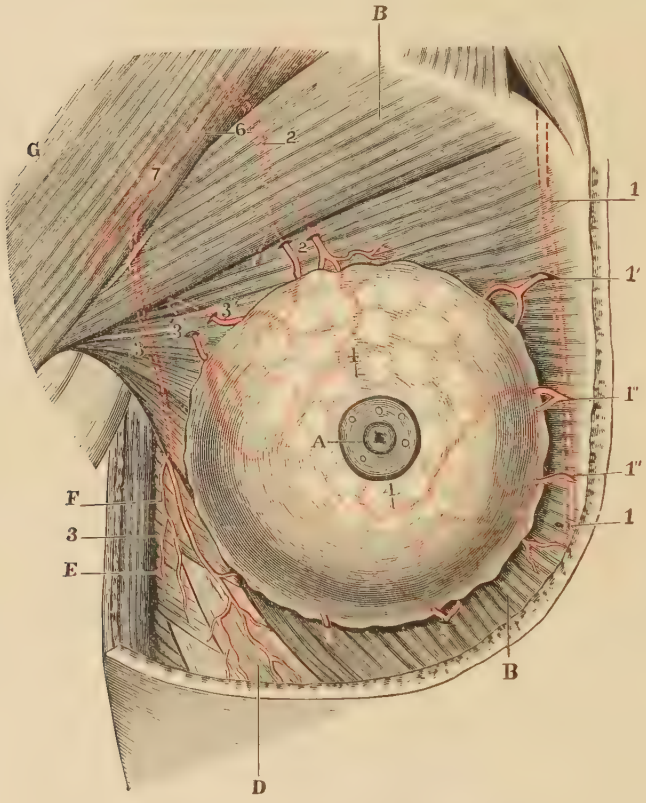
Anatomical arrangement of milk-ducts.

manner. Quain states that there is no muscular tissue in the walls of the ducts. This is certainly not true of the larger ducts. Near the nipple the tubuli lactiferi show the presence of unstriped muscular fibres interlacing and taking courses both circular and longitudinal. The latter may be traced for a certain distance into the lobes, and some investigators even claim to have discovered stray fibres in the interlobular ducts. The epithelium of the ducts varies in different parts of the gland. That of the lobular and interlobular ducts resembles the epithelium of the acini. That of the main duct is distinctly cylindrical, except very near its termination, where it changes to the squamous variety.

When formed by the union of the interlobular ducts the tubuli lactiferi converge toward the nipple Beneath the areola they form sac-like

dilations or *ampullæ*. During lactation the ampullæ are about 12 mm. in length, and 6 mm. in diameter. They act as reservoirs for the milk secretion during the intervals of suckling. Beyond the ampullæ the ducts contract in size and lie side by side in the nipple. The central ones are somewhat the larger. All open independently of one another and by contracted mouths at depressions upon the apex of the nipple.

FIG. 45.



Showing arterial supply of breast. (TESTUT.)

A. Mammary gland. B. Pectoralis major muscle. D. External oblique muscle. E, F. Digitations of serratus magnus muscle. G. Deltoid muscle. 1. Internal mammary artery. 1′, 1″. Perforating branches of the same. 2. Superior thoracic artery. 2′. Branches of the same. 3. Long thoracic artery. 3′. Branches of the same. 4. Superficial vessels of the breast. 5. Perforating branches from the aortic intercostal arteries. 6, 7. Axillary artery.

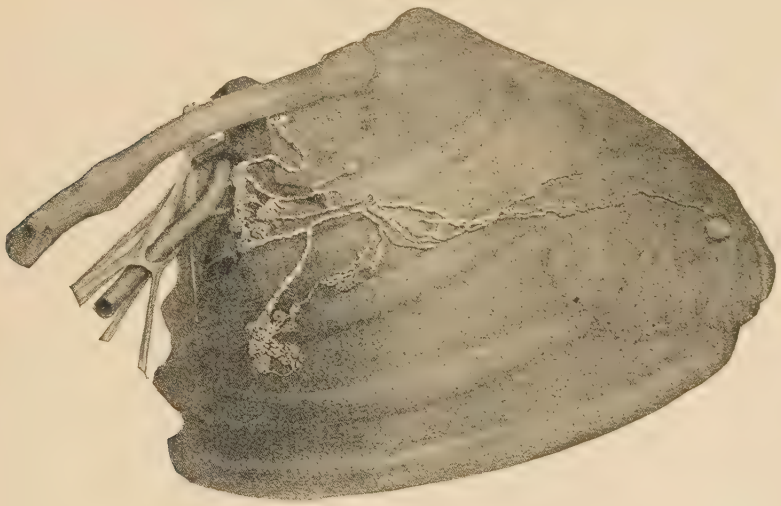
The arteries of the breast are numerous but small. They do not accompany the ducts, but enter at the base of the gland. The inner and greater portion of the breast is supplied by the internal mammary artery, the anterior or perforating branches of which pierce the intercostal spaces to reach it. The anterior intercostal branches of the internal mammary artery and the aortic intercostals with which they anastomose, in like manner supply the inner portion of the mammary gland. The outer portion gets its blood-supply from the axillary artery through its long thoracic and acromio-thoracic branches. To the long thoracic branch of

the axillary artery is frequently applied the name *external mammary*. An accessory external mammary branch may also be given off from the axillary artery and go to the supply of the breast. A rich capillary network is found upon the outer walls of the acini.

The blood is returned from the breast through superficial and deep veins. The deep veins accompany the arteries for the most part. The superficial veins form an anastomosing circle at the base of the nipple (*circulus venosus* of Haller). They spread over the surface of the breast and end in the superior thoracic vein. The superficial veins are especially noticeable during lactation.

The nipple is exceedingly vascular, and the vessels are surrounded by bundles of unstriped muscular tissue. The contraction of the muscular fibres upon stimulation compresses the vessels and causes the so-called erection of the nipple. It is not to be understood, however, that the nipple contains any true erectile tissue.

FIG. 46.



Lymphatics of breast and axilla. (COOPER.)

The lymphatics of the breast are abundant. They form plexuses in the connective tissue about the acini and between the lobules. They are found accompanying the smaller vessels and in the sheaths of the larger ones. All freely communicate. There are, beside, sac-like dilatations in the skin and fascia, from which cutaneous and subcutaneous lymphatics originate. The lymphatics from the inner portion of the breast accompany the perforating arteries and empty into the mediastinal glands. Those from the outer portion unite and form three or four large trunks. They proceed to the axillary glands. A few canals from the vicinity of the nipple empty into a gland situated beneath the outer border of the clavicle.

The nerve-supply to the breast is principally from the intercostal nerves through the lateral cutaneous and the anterior terminal branches.

The descending branches of the superficial cervical plexus also contribute cutaneous filaments. The glandular twigs which accompany the ducts to the acini have been traced by Eckhard from the fourth, fifth, and sixth intercostal nerves. On account of the free communication between the spinal nerves and the gangliated cord, sympathetic nerves are conducted to the mammary gland. "In the nipple many nerves end in tactile corpuscles in the papillæ, and some of those in or near the areola enter Pacinian corpuscles" (Quain).

In the periods between lactation the acini collapse, but do not return to their former undeveloped condition, and the connective tissue contains a greater amount of fat than before the gland became functionally active. At the close of the child-bearing period the whole structure undergoes atrophy, so that in old age the glandular tissue has practically disappeared.

PART II.

PHYSIOLOGY OF PREGNANCY.

CHAPTER II.

MENSTRUATION.—OVULATION.—DEVELOPMENT OF THE OVUM.

MENSTRUATION.

This is the periodical discharge of blood from the uterus which takes place during the whole of genital life—the years included between puberty and the climacteric—the period of pregnancy excepted. In occasional instances menstruation may also occur during the early months of gestation, but after the fifth month, when the decidua reflexa has joined the vera and disappeared, the normal source of the discharge is completely shut off, and bleeding from the uterus subsequent to this time must be due either to a diseased condition of the cervix or to some other pathological condition of the uterine tissues.

Menstruation occurs on the average once in twenty-eight days, but it is subject to wide variations in point of time, some women menstruating normally at shorter, others at longer, intervals. The duration of the flow is usually from three to five days, but it may continue for two or three days longer and still remain within normal limits. Every healthy woman must be considered a law unto herself in the matter of frequency and duration. The source of the flow is the mucous membrane of the uterine fundus and body.

At first the discharge is made up of mucus, epithelia, and some blood ; later it consists of nearly pure blood, and finally of a diminishing amount of blood, serum, epithelia, granular débris, and some fat. The reaction of the discharge is acid from the presence of phosphoric and lactic acids ; it is non-coagulable from the admixture of mucus; and it has a peculiar penetrating odor due to contained fatty acids. From four to eight ounces are lost at each period.

The function is associated with more or less general and local disturbance, especially of a secondary or reflex character.

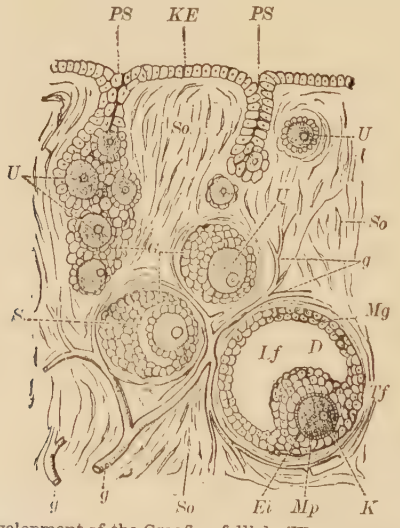
The primary cause of the flow is to be sought in the ovary, viz., in ovulation. The processes affecting the uterus during the menstrual act may be considered as taking place in four stages, as follows : (1) A period of construction in which the uterine mucosa becomes tumefied, the stroma is infiltrated with serum which often contains blood, the vessels are dilated, and the number of epithelial cells lining the glands is augmented, while the glands themselves become dilated and filled with mucus. This condition is probably similar to that which follows impregnation, the swollen mucous membrane in this instance being called the *decidua menstrualis*. (2) A period of destruction in which the integrity

of the uterine lining is destroyed, the exposed capillary vessels rupture and pour out their blood, which carries with it the products of disintegration. (3) A period of regeneration in which the swelling and hyperæmia subside, and the uterine lining is rapidly renewed by the proliferation of the stroma cells and the upgrowth of the epithelial cells of the glands. This takes place between the sixth and the eighteenth day from the beginning of the period (Westphal). These changes are followed by (4) a period of quiescence or repose, in which no active changes take place in the uterine lining.

OVULATION.

This consists in the periodical discharge of the fully ripened ovum from the Graafian follicle, and, like menstruation, is probably confined to the period of genital life. The development of the egg-cell from the germinal epithelium is described elsewhere. The young ovum is at first surrounded by a single layer of small cells, but by division of these a wall several cell-layers deep is finally formed. Between the external and the innermost layer a fissure is then developed, the latter becoming filled with fluid—the *liquor folliculi*. The innermost layer of cells is thus forced away from the wall, and as the fluid increases a

FIG. 47.



Development of the Graafian follicle (WIEDERSHEIM).

KE. Germinal epithelium, from which Pflüger's tubes, *PS*, in ovarian stroma are developed. *So*. Ovarian stroma. *g, g*. Small vessels. *U, U*. Primitive ova. *S*. Space between membrana granulosa and ovum. *If*. Liquor folliculi. *D*. Discus proligerus. *Ei*. Ripe ovum, with germ-vessicle and germinal spot (*K*). *Mp*. Membrana pellucida. *Tf*. Muscular sheath of follicle. *Mg*. Membrana granulosa.

vesicle is formed, the cells adhering around the ovum as the *discus proligerus*, which remains attached to the follicle wall at one point only, the farthest from the surface. The wall of the Graafian follicle is composed of the following layers from within outward: (*a*) *membrana granulosa;* (*b*) the *membrana propria*, a very thin basement membrane; (*c*)

the *tunica propria*, which carries the smaller bloodvessels and is composed of more or less fibrous tissue; and (*d*) the *tunica fibrosa*, containing much fibrous tissue, and through which run the larger bloodvessels.

At one place in the follicle wall (the *stigma*) no bloodvessels are developed, and it is at this point that rupture occurs and permits the escape of the ovum surrounded by the discus proligerus, now called the *corona radiata*, and the liquor folliculi. Just before rupture of the follicle certain preparatory changes take place, the maturation of the follicle, which lead up to the event. The bloodvessels become engorged, the internal layer of the wall becomes thickened and is thrown into folds, and the liquor folliculi is largely augmented. At this time the Graafian follicle projects from the surface of the ovary as a currant-like cyst.

After the escape of the egg-cell the follicle undergoes certain changes, the nature of which is dependent upon the fertilization or otherwise of the ovum, the product in either instance being the *corpus luteum*. When fecundation of the ovum does not take place the corpus luteum of menstruation, *corpus luteum spurium*, is formed. The bursting of the follicle relieves the pressure on the surrounding bloodvessels, which rupture into the cavity, the discharged blood forming a firm clot, the *corpus hæmorrhagicum*, which, however, does not become attached to the follicle wall. Spindle-shaped connective-tissue cells and large cells containing pigment-granules now penetrate the clot, and the follicle wall becomes thickened and thrown into folds, thus encroaching more upon the central clot. Contraction of the clot follows, and capillary loops surrounded by newly formed cells from the follicle wall enter its substance. As these changes progress the granules of *lutein* in the external layer of the clot give rise to its yellow appearance. The further changes in the corpus luteum are of a retrograde character, the clot and newly formed products gradually disappearing, until after eight or nine weeks only a small cicatrix on the surface of the ovary remains. It is stated by Dalton that seven or eight months may elapse before total obliteration of the follicle takes place.

In the event of impregnation, the corpus luteum of pregnancy—*corpus luteum verum*—results. Under this condition, instead of diminishing in size, the corpus luteum continues to enlarge up to the fourth month, the walls becoming thicker and their convolutions more numerous. From the fourth to the seventh month a stationary period occurs, but from this time on the corpus luteum begins to decline, so that at term it is much smaller than at the fourth month. After labor the retrograde changes are rapid, and by the eighth or ninth week post partum nearly all traces of the corpus have disappeared.

Although menstruation and ovulation should not be considered as necessarily coincident processes, it is altogether probable that the conditions which influence the one have also an effect upon the other, and that, as a rule, the two functions occur simultaneously, and are to a greater or less extent interdependent.

DEVELOPMENT OF THE OVUM.[1]

Maturation; Fertilization. The fully developed human ovum is a single cell, more or less spherical in form, about 0.2 mm. ($\frac{1}{125}$ inch) in

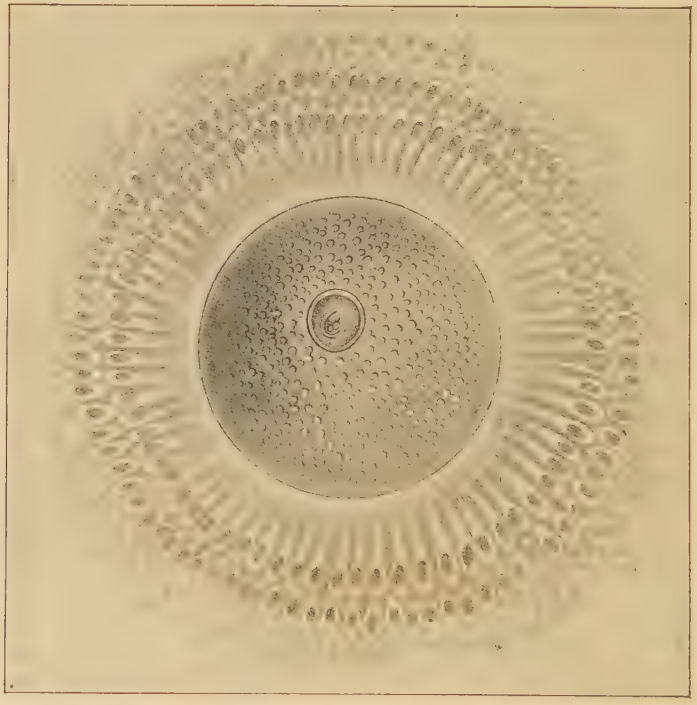
[1] Most of the phenomena described as occurring in the early development of the embryo have not been observed in the human species, but are taken from studies made on the lower animals.

diameter, and composed of a yolk, a nucleus, a nucleolus, and two enveloping membranes. (Fig. 48.)

The outermost membrane, *Zona radiata* or *Zona pellucida*, in the mature ovum is rather thick and tough, and presents a striated appearance, owing to the presence of numerous minute pore-canals, through which nutrition is supposed to be furnished the ovum. It is derived from the secretions of the ovarian tissues.

The second, or *Vitelline membrane*, lies in close contact with the yolk from which it is developed, and is a very thin and delicate covering.

FIG. 48.



Rabbit's ovum (after WALDEYER).

Between the zona and the second membrane there is a narrow cleft, the *Perivitelline space*, which permits free motion of the ovum within its external covering.

The *Yolk* or *Vitellus* is a clear, somewhat granular substance, consisting of yolk-grains (food-yolk or deutoplasm), some fat granules, and protoplasm. The latter is usually increased in amount at one point in the ovum, around the nucleus, and this part is designated the animal pole, while the corresponding opposite point, where the protoplasm is less, is known as the vegetative pole.

The *Nucleus* of the ovum, also called *germinal vesicle* or *vesicle of Purkinje* from its discoverer, occupies an eccentric position in the egg-cell, and is surrounded by a nuclear membrane. A reticulum or net-

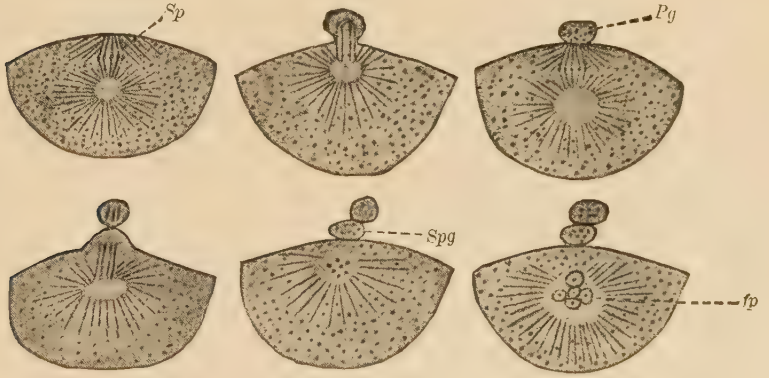
work of achromatic threads radiates from the nucleolus through the interior of the nucleus ; the meshes of this structure are filled with a clear fluid, the nuclear sap.

The *Nucleolus, Germinal spot* or *spot of Wagner,* is also placed eccentrically in the nucleus, and is largely composed of chromatin—a substance having a marked affinity for staining reagents.

Maturation of the Ovum. The female cell or ovum, thus briefly described, although fully developed, is still in an unripe condition, unprepared for the reception of the male fecundating element, and must undergo a series of changes, which principally affect the nucleus and nucleolus, before fertilization can be accomplished. These changes are known as the *maturation* of the ovum, and take place just before or just after the ovum has escaped from the Graafian follicle, occurring without reference to the future fate of the egg-cell. Maturation has as yet never been observed in the human ovum, and knowledge of the subject has been derived from the study of the process in vertebrate and invertebrate animals.

The first step in the process of maturation is the contraction of the entire yolk. The nucleus then travels toward the animal pole of the egg, loses its sap, which becomes mingled with the surrounding protoplasm, and the nuclear membrane shrinks and finally disappears. Achromatic threads then appear in the nucleus giving rise to a spindle-shaped body, which lies parallel with the surface of the egg. Each thread bears a chromatic granule near its middle, which gives rise to the appearance of a dark band near the center of the nuclear spindle.

FIG. 49.



Formation of polar globules in arteria gracialis (after O. HERTWIG).

Sp. Nuclear spindle. *Pg.* First polar globule. *Spg.* Second polar globule. *fp.* Female pronucleus.

A clear space at each end of the spindle then develops threads which run to the surrounding yolk substance, the sun-like appearance thus produced being termed the *Amphiaster.*

The nuclear spindle now assumes an upright position, the chromatin granules divide, each half travelling toward its corresponding end of the spindle, while the spindle itself surrounded by protoplasm advances to the surface of the egg and pushes outward one-half of its entire substance into the perivitelline space. This extruded portion then becomes constricted off from the rest of the spindle, and forms the first *polar globule.* (Fig. 49.)

The remnant of the spindle in the egg then a second time undergoes the changes just described, and forms in the same manner a *second polar globule*. Three-fourths of the original spindle is thus cast off. The remnant of the spindle retires into the egg, disappears temporarily, and is then re-formed as the *female pronucleus*.

No entirely satisfactory explanation for the formation of the polar globules has been advanced; but it is supposed to be effected either to lessen the size of the cell nucleus in order to make room for the male element, or to prevent self-fertilization, parthenogenesis.

Fertilization. The ovum, now fully ripe and in condition for fertilization, migrates through the Fallopian tube toward the uterus. The point at which the two elements, male and female, meet, is not definitely known, but it is supposed to be the outer portion of the tube in the majority of instances.

Recent observations go to show that impregnation may take place anywhere from the Graafian follicle in the ovary to the cavity of the uterus.

FIG. 50.

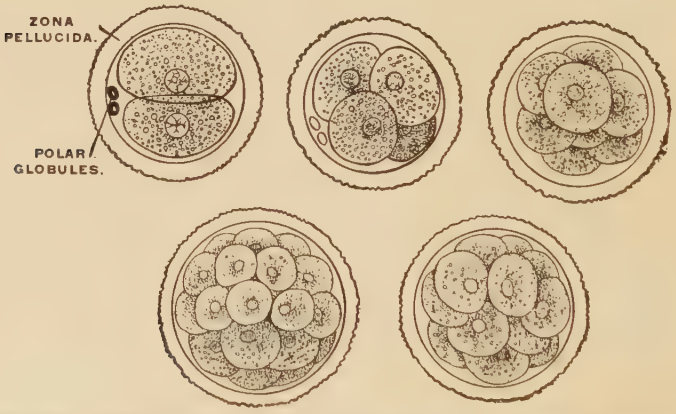


Diagram showing first stages of segmentation in a mammalian ovum (ALLEN THOMPSON, after E. VAN BENEDEN).

Of the whole number of ova which are discharged from the ovary it is quite probable that many do not enter the tube at all, but fall into the peritoneal cavity and perish. In very rare instances the ovum from one ovary is known to have passed entirely around the uterus, and entering the tube of the opposite side to have there become fertilized.

When the spermatozoa and ovum meet, the former penetrate the zona radiata, and the first spermatozoon which approaches the vitelline radially is met by a slight protrusion of the protoplasm of the egg, which it penetrates and, passing inward, enters the yolk. Here the spermatozoon loses its tail, and the head and middle-piece, composed largely of chromatin, become the *male pronucleus*.

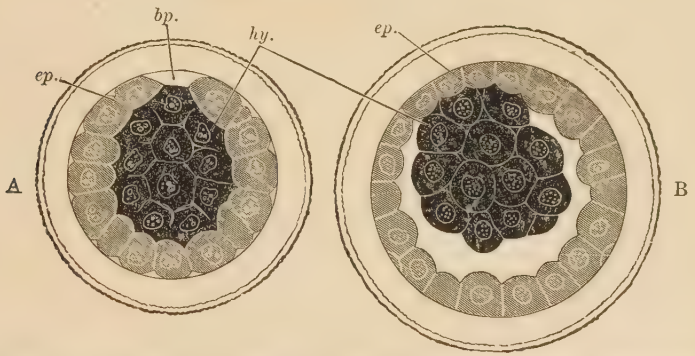
But one spermatozoon is necessary for fertilizing the ovum, and as soon as this has penetrated the yolk a repellent action seems to be set up by the latter, whereby other spermatozoa are prevented from passing inward.

After a short resting stage the male and female pronuclei approach

each other, and, their walls coming in contact, fuse, finally disappear, and a single nucleus, somewhat smaller than the original one of the ovum, remains as the *segmentation nucleus.*

The ovum now enters upon a new stage of development, in which the entire egg-cell is broken up into a great number of smaller cells, each of which possesses a nucleus. This total division of the ovum is known as *holoblastic segmentation*, the individual cells of which are called *blastomeres.* (Fig. 50.) This change first affects the segmentation nucleus which divides by the indirect method (karyokinesis), and forms two nuclei. A groove then appears in the axis of the ovum, marked by the polar globules, which by continuous deepening completely divides the ovum into two cells. A second meridional cleavage plane divides the two cells into four, the four are then divided into eight, then into twelve segments, and, the process continuing, the ovum is finally converted into a mass of cells, which, from its resemblance to the fruit, is called

FIG. 51.



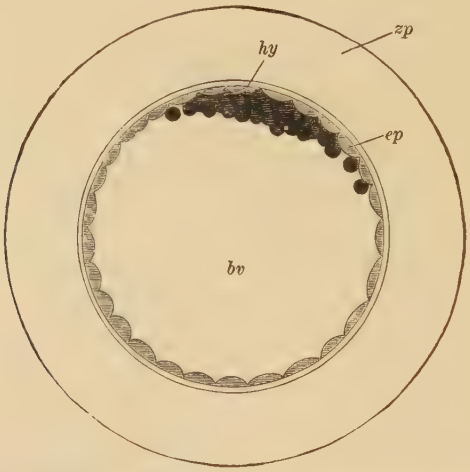
Optical section of an oosperm of a rabbit, at two stages closely following upon segmentation (from Balfour, after Ed. v. Beneden): *ep*, ectoderm; *hy*, primary entoderm; *bp*, the opening in the ectodermic layer at one point, named blastopore by E. van Beneden; this is not a true blastopore. The shading of the ectoderm and entoderm is diagrammatic.

the *Morula* or mulberry-body. The process of cell division, although described as equal, is not so in fact, for the external cells divide more rapidly than the internal, so that there can be differentiated two distinct layers, a superficial layer in which the cells are small, and an internal layer in which they are much larger. Vacuolization in the cells at one pole of the ovum now takes place and these spaces running together, a small cavity, the *segmentation cavity* is formed in the interior of the mass. This is later filled with a clear albuminous fluid, which increases rapidly in amount, so that the ovum soon becomes distended into a vesicle, the *blastodermic vesicle* (Fig. 51.) On section this is seen to consist of a cavity surrounded by an enveloping layer of cells, within which at one point a collection of larger cells is attached the inner cell-mass. (Fig. 52.)

That part of the enveloping layer over the cell-mass is called *Raubers's layer.* The ovum has now increased in size so as to be visible to the naked eye. At that point at which the inner cell mass is attached the blastodermic vesicle is composed of three layers, the rest of the wall having but two.

The first of these layers, the *covering layer* or *trophoblast*, extends as a single layer of cells around the vesicle, immediately under the zona pellucida, and is a temporary structure.

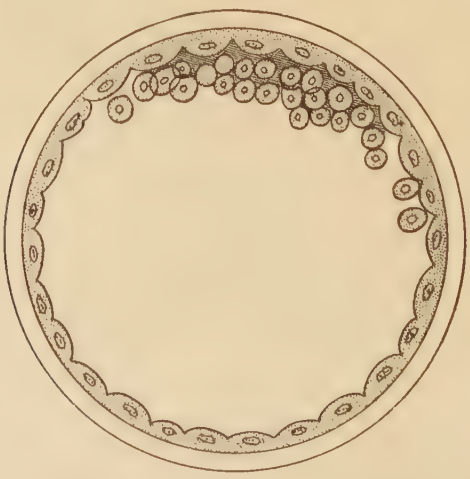
Fig. 52.



Rabbitt's ovum between seventy and ninety hours after impregnation (after van Beneden).

Below the trophoblast a second layer of cells, the *ectoderm*, also extends around the vesicle; while the third or innermost layer, the *endoderm*, is formed by the peripheral growth and extension of the cells of the inner cell-mass and ultimately lines the ectoderm.

Fig. 53.

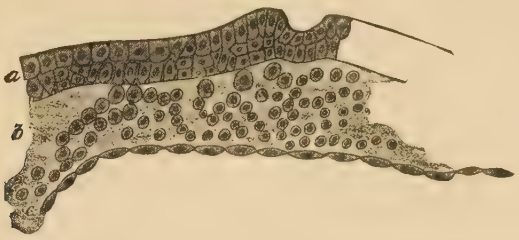


Later stages of segmentation in a mammalian ovum (Thomson, after E. van Beneden).

The covering layer disappears and from the cells of the two primary layers described a third layer—the *mesoderm*—is developed, and grows outward from the median axial line by the proliferation of its own cells.

(Fig. 54.) Unlike the other two layers the mesoderm does not at first extend entirely around the ovum, but is limited in growth by the germinal or embryonic area (Fig. 55.), that portion of the egg in which the future embryo will be developed. The mesoderm grows in all directions,

FIG. 54.

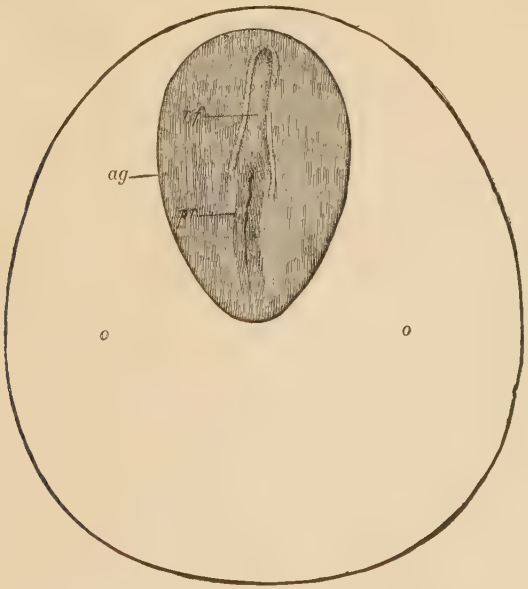


Transection of eighteen-hour chick embryo, showing beginning of medullary groove and the three layers (MANTON collection).

a. Ectoderm. *b*. Mesoderm. *c*. Entoderm.

but as it extends cephalad it sends out two projections, which, leaving a space (the *proamnion*) just in front of the future head, again unite and spread outward. (Figs. 56, 57, 58.)

FIG. 55.



Embryonic area of rabbit (after KÖLLIKER).

At a later period two distinct varieties of cells arise from the mesoderm—*mesothelium*, which possesses the characteristics of endothelium—and from this *mesenchyme* or embryonic connective tissue.

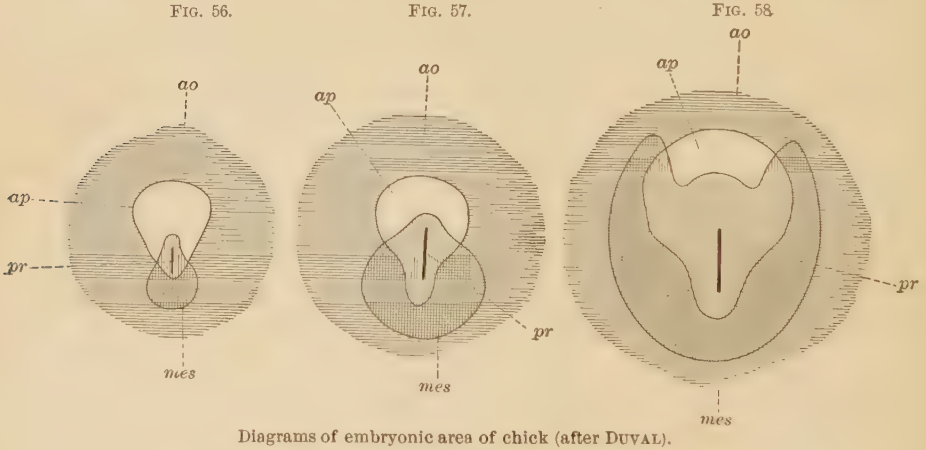
From the three primary layers all the parts and tissues of the body are developed.

From the Ectoderm: The skin and its epidermal structures—the mammary glands, hair, nails, epithelium of the cornea; the lens of the eye; the cerebrospinal system—the nerves and ganglia; the optic vesicles and nerve; cavity of the mouth, enamel of teeth, hypophysis; anus, chorion, amnion, placenta.

From the Mesoderm: The muscles, bones, connective tissue, peritoneum, pleuræ, pericardium, urogenital apparatus (kidneys, testes, uterus, Fallopian tubes, and ovaries), spleen, bloodvessels, blood, lymphatics, fat-cells, marrow.

From the Entoderm: The œsophagus, stomach, intestines, epithelium of digestive tract, thyroid and thymus glands, tonsils, lungs, liver, pancreas, bladder.

At an early stage a linear streak—the *primitive streak*—(Fig. 55.) makes its appearance just behind the center of the embryonic area, and runs backward to near the margin of the shield. In later stages a distinct



Diagrams of embryonic area of chick (after Duval).

ao. Area opaca. *ap.* Area pellucida, the proamnion in third figure. *pr.* Primitive streak. *mes.* Mesoderm.

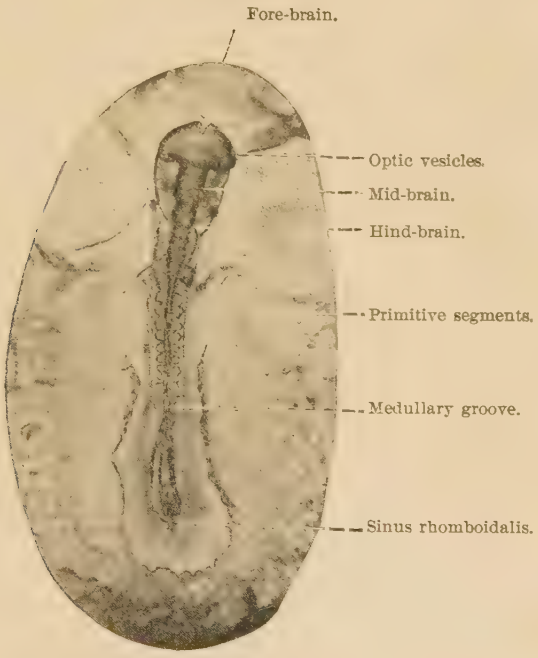
spot, *Hensen's node*, marks the anterior end of the streak. In front of the primitive streak the ectoderm thickens into a band of cells several rows deep on either side of the median axial line. These thickenings are the *medullary plates*. By the upgrowth of the edges of the plates a groove is formed—the *medullary groove*—which by the arching inward and uniting of the lateral folds is converted into a tube, the *medullary* or *neural canal*. The formation of the canal begins in the future cervical region of the embryo, and progresses most rapidly cephalad; the posterior portion, the end of which appears to embrace the beginning of the primitive streak, remains open for some time, and is known as the *sinus rhomboidalis*. (Fig. 59.)

The neural canal is the proton of the cerebro-spinal system, one-half of its entire extent entering into the formation of the brain. Immediately below the developing neural canal a rod of cells is formed in the endoderm, and extends from the future hypophysis to the anterior end of the primitive streak. This is the *notochord*, or chorda dorsalis (Fig. 60,

6 *Cd.*), a temporary structure which represents the primitive axial skeleton of vertebrates. Developed from the endoderm, the chorda is at first a part of that layer, but the latter soon growing under it, it becomes separated off and assumes a position directly beneath the neural canal, with which, however, it does not unite.

On either side of the neural groove the mesoderm becomes thickened into two longitudinal bands. That portion of the band nearer the groove is thicker and is known as the *segmental zone*, while the external portion which thins toward the blastodermic wall is *parietal zone*.

FIG. 59.



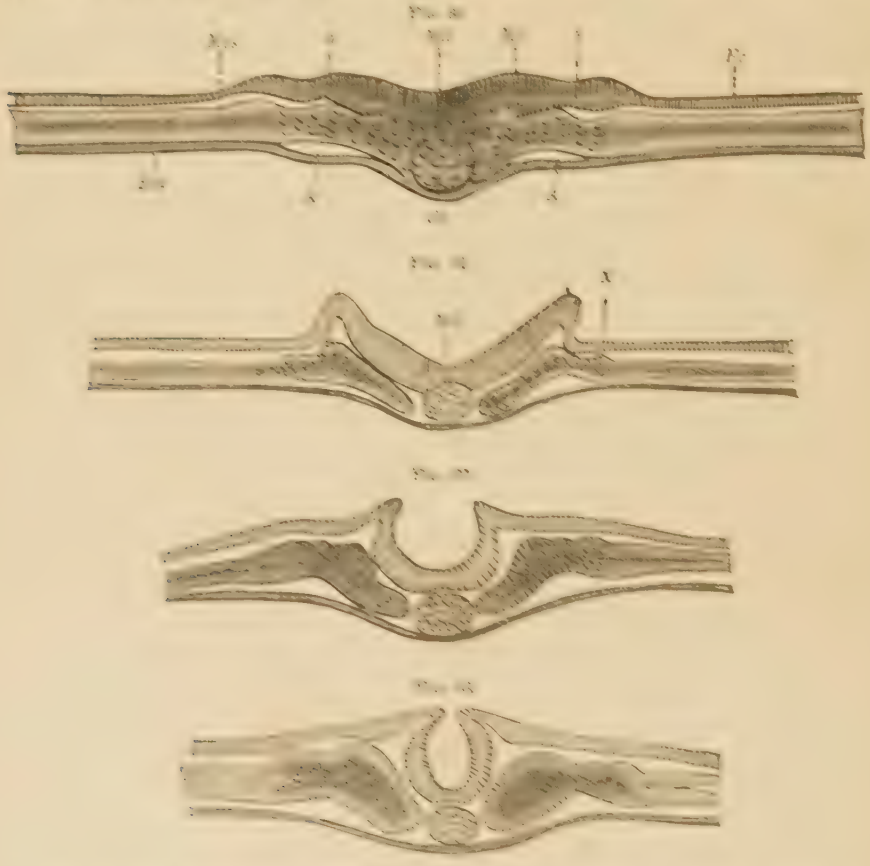
Chick embryo. Second day. (MANTON collection.)

The segmental zone undergoes transverse cleavage which gives rise to a series of cubical bodies—the *mesodermic somites*. (See Figs. 60 to 65). These appear first in the neck region of the embryo, and gradually extend caudad. The *mesodermic somites* give rise to many of the voluntary muscles of the trunk, and extremities, and are connected with the formation of the future vertebræ.

Externally to the parietal zone of the *mesodermic somites*, the mesoderm splits into two layers, an upper or external leaf going with the ectoderm to form the *somatopleure* or primitive body wall, and a lower or internal leaf which, with the endoderm, forms the *splanchnopleure* or primitive intestinal wall (see Figs. 60 to 65). The space between these two leaves is the *cœlom* or body cavity (pleuro-peritoneal cavity).

Folding off of the Embryo. Up to this time the embryo appears to lie flat on the blastodermic wall, but now changes arise which tend to carry it more and more from its surface position and to force it downward into the cavity of the vesicle. A groove first appears just in front of the

cephalic end of the embryo (Plate XII., Fig. 11), the *head fold*, and later one behind, the *tail fold*, and on either side the *lateral folds* are formed. As the result of the deepening of these folds, the embryo becomes partly constricted off from the rest of the blastodermic vesicle. As the folds deepen, spaces are shut off at the anterior and at the posterior ends of the embryo, immediately below the notochord. These cavities are the beginning of the primitive alimentary canal; that in front being the *fore-gut*, and that behind the *hind-gut*. The middle portion of this canal, as it soon comes to be, is still in connection with the yolk-sac or umbilical vesicle, by the wide omphalomesenteric or vitelline duct. (Plate XII., Figs. 8 to 10.)



The Fetal Appendages and the Uterine Membranes. As the result of the folding off of the embryo, all of the extra-embryonic portion of the egg, which constitutes the yolk-sac, becomes partially constricted off as a pear-shaped body which is connected by its neck and by the primitive intestinal canal. At a later period the neck of the vesicle becomes [illegible] into a long thin pedicle, and pedicle and sac are finally [illegible] in the abdominal stalk during the formation of the umbilical cord. The yolk-vesicle supplies for a time partial nourishment to the

embryo and its appendages. During its passage through the Fallopian tube the ovum also derives more or less nourishment from the secretions of the parts by which it is surrounded. As development of the embryo goes on a larger source of supply is demanded, to which end changes take place, bringing the embryo into direct relation with the maternal circulation, by which the necessary nourishment for growth and development is obtained.

FIG. 64.

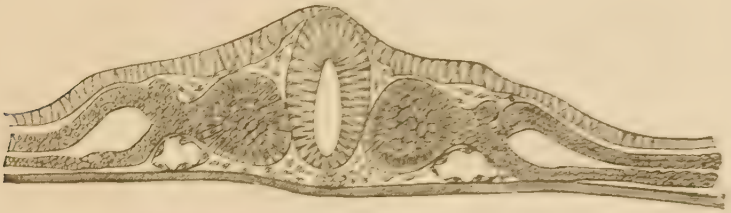
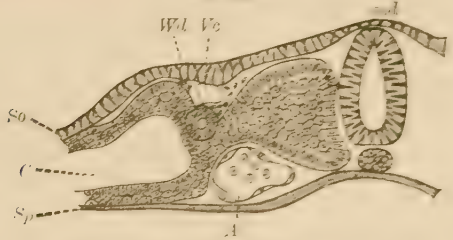


FIG. 65.

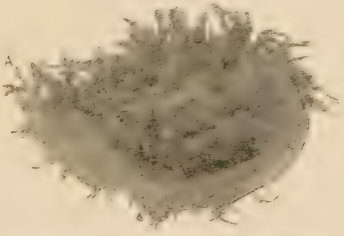


FIGS. 61-66.—Development of the neural canal (after WALDEYER).

Ec. Ectoderm. *Ent.* Entoderm. *Mes.* Mesoderm. *a, b.* Prota of primitive segments (protovertebræ). *Md.* Medullary groove. *Mp.* Medullary plate. *A.* Aorta. *Cd.* Notochord. *X.* Wolffian ridge. *Wd.* Wolffian duct. *Vc.* Cardinal vein. *So.* Somatopleure. *Sp.* Splanchnopleure. *C.* Cœlom.

At a very early period all of the extra-embryonic somatopleure becomes covered with a growth of delicate villi, which give it a shaggy appearance. This is the *primitive chorion;* the whole ovum at this time is sometimes called the *chorionic vesicle.* (Fig. 66.)

FIG. 66.



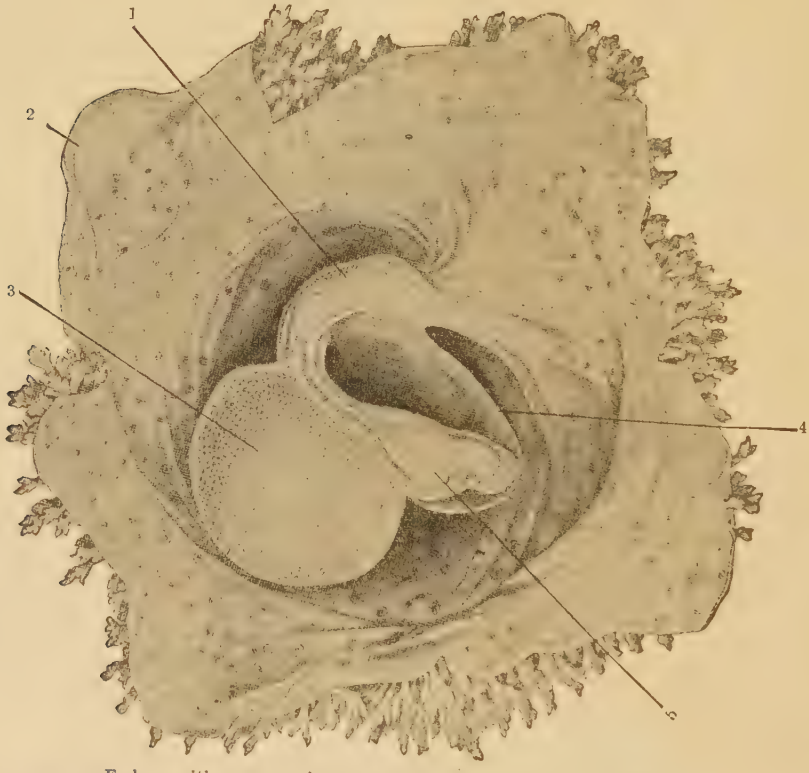
Human ovum of second week, showing chorionic tufts. *A.* Enlarged four times. (MANTON collection.)

At first the villi are composed only of ectodermal cells, but later the mesoderm extends into each hollow villus. The whole chorion very early develops bloodvessels, but most of these soon become obliterated.

Coincident with the folding off of the embryo the external walls of the folds grow upward and, arching over the back of the embryo, unite

in the mid-dorsal line. The anterior fold, cephalic cap, probably grows more rapidly than the lateral folds, but little is actually known regarding this phenomenon from observations on human embryos. The embryo in this way becomes inclosed in a thin membranous sac—the *amnion*. As will be seen by reference to Plate V., the amniotic folds are composed

FIG. 67.



Embryo with open membranes. Fifteen to eighteen days. (COSTE.)

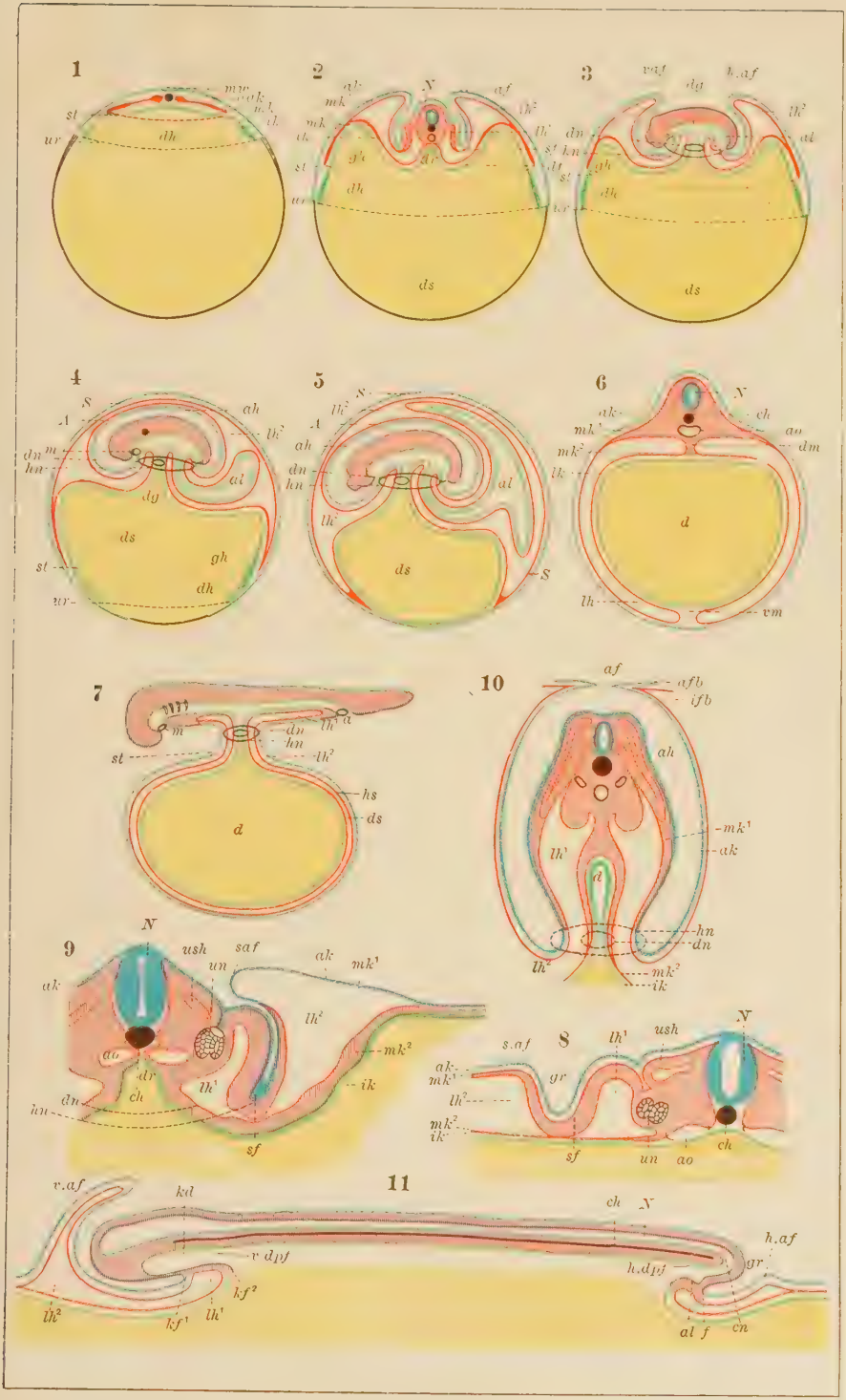
1. Allantois (abdominal stalk). 2. Parietal mesoblast. 3. Vitelline membrane, yolk. 4. Amnion. 5. Heart.

of two layers, an upper, external leaf—the *false amnion*—made up of ectoderm externally and lined with mesoderm, and a lower or internal leaf—the *true amnion*, which has a layer of mesoderm above and ecto-

DESCRIPTION OF PLATE XII.

Folding off of embryo and formation of amnion and allantois in fowl's egg (after O. HERTWIG).

a. External germinal layer. *mw.* Medullary groove. *N.* Neural canal. *af.* Amnion fold. *vaf.* Anterior. *haf.* Posterior. *saf.* Lateral amniotic folds. *A.* Amnion. *ah.* Amniotic cavity. *S.* Serous covering. *hn.* Umbilicus. *sf.* Lateral folds. kf^1, kf^2. Head fold. *afb.* External. *ifb.* Internal layers of amnion. *ur.* Border of embryonic area. *dr.* Intestinal groove. *dg.* Vitelline duct. *al.* Allantois. *ds.* Vitellus. *dn.* Intestinal portion of umbilicus. *mk.* Middle germinal layer. mk^1. Parietal leaf of mesoderm. mk^2. Visceral leaf of mesoderm. *st.* Sinus terminalis. *dm.* Dorsal. *vm.* Ventral mesenterium. *lh.* Somatic cavity. lh^1. Embryonal portion. lh^2. Extra-embryonal portion of somatic cavity. Figs. 1, 2, 6, 8, 9, and 10 transections. Figs. 3, 4, 5, 7, and 11 longi-sections of embryo. Figs. 1, 2, 3, 4, and 5 chick embryo. Fig. 6 fish embryo. Figs. 7 and 11 selachian embryo.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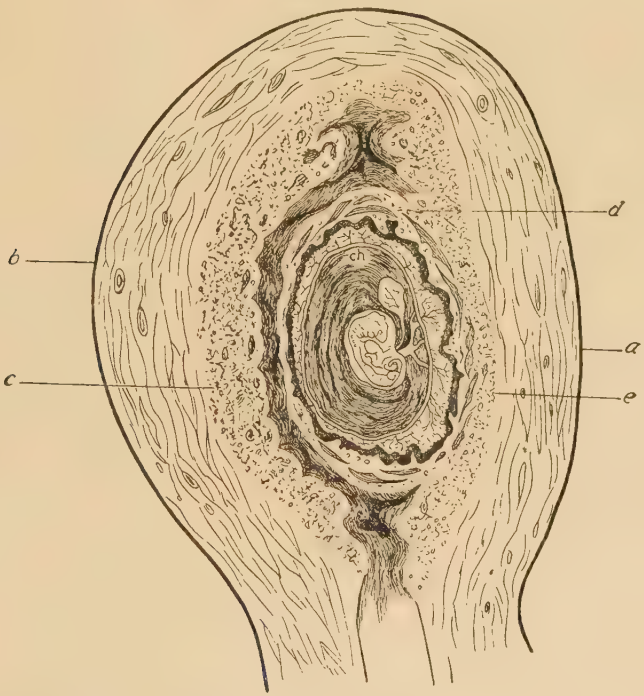
derm below, and hugs the back of the embryo. The space between the false and true amnions is continuous with the embryonic pleuro-peritoneal cavity.

The interval between the embryo and the true amnion later becomes the *amniotic cavity*. At first the amniotic membrane lies in contact with the back of the embryo, but soon a clear fluid, the amniotic fluid or *liquor amnii*, is secreted within the sac, and this increasing in amount rapidly distends the amnion until some time during the third month this membrane comes in contact with the chorion, with which it forms a loose attachment. The liquor amnii is a clear, serous fluid, having a specific

FIG. 68.



Semi-diagrammatic outline of an antero-posterior section of the gravid uterus and ovum of five weeks (modified from ALLEN THOMSON).

a. Anterior uterine wall. *b*. Posterior uterine wall. *c*. Decidua vera. *d*. Decidua reflexa. *e*. Decidua serotina. *ch*. Chorion with its villi.

gravity variously given as from 1.003 to 1.082, an alkaline reaction, and a composition including fixed solid, epithelial scales, lanugo, and other matters derived from the embryo or fœtus, besides water. It amounts to about one or two pints during the last months of pregnancy, but at term is said to have diminished about one-half. The fluid is probably largely derived by transudation from the maternal structures. The function of the liquor amnii is manifold: it maintains an equal distention of the uterus, protects the child from external violence, and permits of its free movements in utero; it prevents injurious pressure on the umbilical cord, and, during labor, softens and lubricates, as well as assists

in the dilation of, the parturient canal. It is, moreover, a source of water-supply to the fœtus, bathing its surfaces, and being swallowed in considerable quantities.

By the formation of the amnion the embryo becomes entirely separated from the chorion except at its caudal end, which remains fixed as the *abdominal stalk*. (Fig. 67.) At an early period a bud-like diverticulum —the *allantois* (see Plate XII., 3 and 4)—develops from the region of the posterior ventral end of the hind-gut, and grows outward through the belly stalk to the chorion, with which it becomes joined and assists in the formation of the placenta.

The allantois and the abdominal stalk, together forming the proton of the umbilical cord.

The impulse started by the fecundation of the ovum inaugurates certain changes in the uterus preparatory to the reception of the fertilized egg, changes which in their earlier stages are probably analogous to those taking place at the menstrual period. The whole uterus enlarges, becomes more vascular, and its mucosa appears more vascular, spongy, and swollen. At the os internum and the openings of the Fallopian tubes the mucous membrane remains thin, so that, as the result of hypertrophy, the parts surrounding these apertures are thrown into folds. The entire thickened lining of the womb is designated as the *decidua vera*. (Fig. 69.)

As soon as the chorionic vesicle enters the uterus, it is usually arrested in one of the folds nearest the tube opening, and at once attaches itself

FIG. 69.

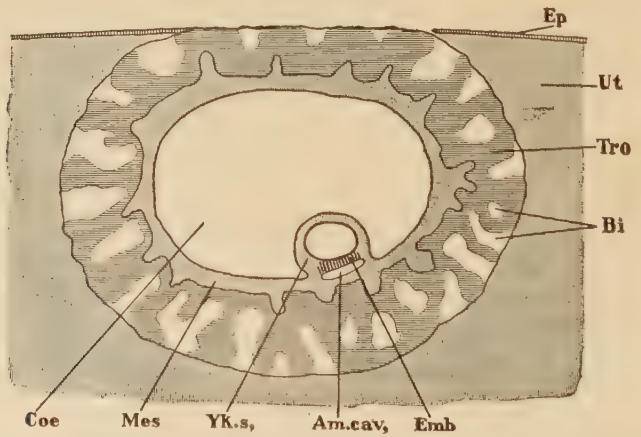


Diagram based on Peter's ovum. *Ep*, uterine epithelium; *Ut*, mucous membrane (decidua) of uterus; *Tro*, trophoderm; *Bi*, spaces formed by degeneration of trophoderm; maternal blood enters these spaces from the decidual bloodvessels; *Emb*, embryonic shield; *Am. cav*, amniotic cavity; *Yk.s*, yolk sac; the entodermal lining of which is indicated by a heavy black line; *Mes*, chorionic mesoderm; *Coe*, extra embryonic celom.

In the human species as well as in many mammals this process of attachment, called the *implantation* of the ovum, probably results from the corrosion of the uterine mucosa by certain modified cells of the ectodermal layer—the *trophoderm* of Minot,—a cavity being eaten out in which the ovum lodges. The edges of the opening thus formed then close, constituting the *decidua reflexa*, and the ovum is shut off from the uterine cavity. As the amnion expands the decidua reflexa is pushed more and

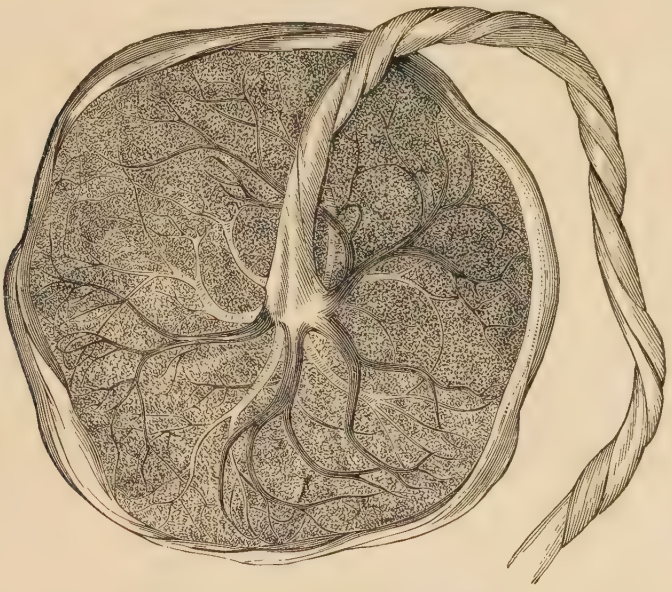
more toward the decidua vera, with which it ultimately comes in contact and unites during the fourth month.

The reflexa is a temporary structure and disappears by degeneration and absorption by the fifth month of pregnancy.

That part of the uterine mucosa upon which the chorionic vesicle first finds lodgement becomes the *decidua serotina;* it plays an important rôle in the future vascular arrangement between the mother and child.

The Placenta and Umbilical Cord. When the chorionic vesicle reaches the uterus and becomes implanted, hyportrophic degeneration of the trophoderm takes place giving rise to a series of irregular spaces which become the intervillous spaces of the future placenta. It is probable that the corrosive action of the trophoderm is exerted on the walls of the blood vessels with which it comes in contact, so that these are opened

FIG. 70.



The internal or fœtal surface of the placenta.

and maternal blood passes into the intervillous spaces, an extra vascular circulation being established at an early period. While this is going on papillary outgrowths from the chorionic mesoderm penetrate the trophoderm, become branched, and ultimately constitute the chorionic villi. A covering of thin degenerated trophoderm extends for a time over the developing villi and consists of two layers, an inner, cellular, and an outer, syncytial. Eventually this double layer of cells becomes the chorionic ectoderm. The villi of the serotinal region, increase in size and repeatedly branch, and enter later into the formation of the placenta, so that this part has been called the *chorion frondosum.* The remainder of the villi of the chorion, called the *chorion lævе*, gradually atrophy and disappear some time prior to the fourth month. At term the placenta or afterbirth (Figs. 70 and 71) is a roundish, oval, or kidney-shaped spongy mass, reddish-gray to deep purplish-red in color, with a diameter of six

to eight inches, and weighs about a pound. It is usually thickest at the centre, and gradually thins off toward the edges, which are continuous with the amnion and decidua. The placenta consists of three essential layers: (1) A maternal zone of decidua, (2) a fœtal zone of amnion and chorion, and (3) a middle zone in which both the maternal and the fœtal elements are intimately associated.

The inner or fœtal surface of the placenta, to which the cord is attached excentrically, is smooth and glistening in appearance, and is covered by the amnion, beneath which the two umbilical arteries and one umbilical vein ramify in all directions. The veins are the larger and lie deeper

FIG. 71.

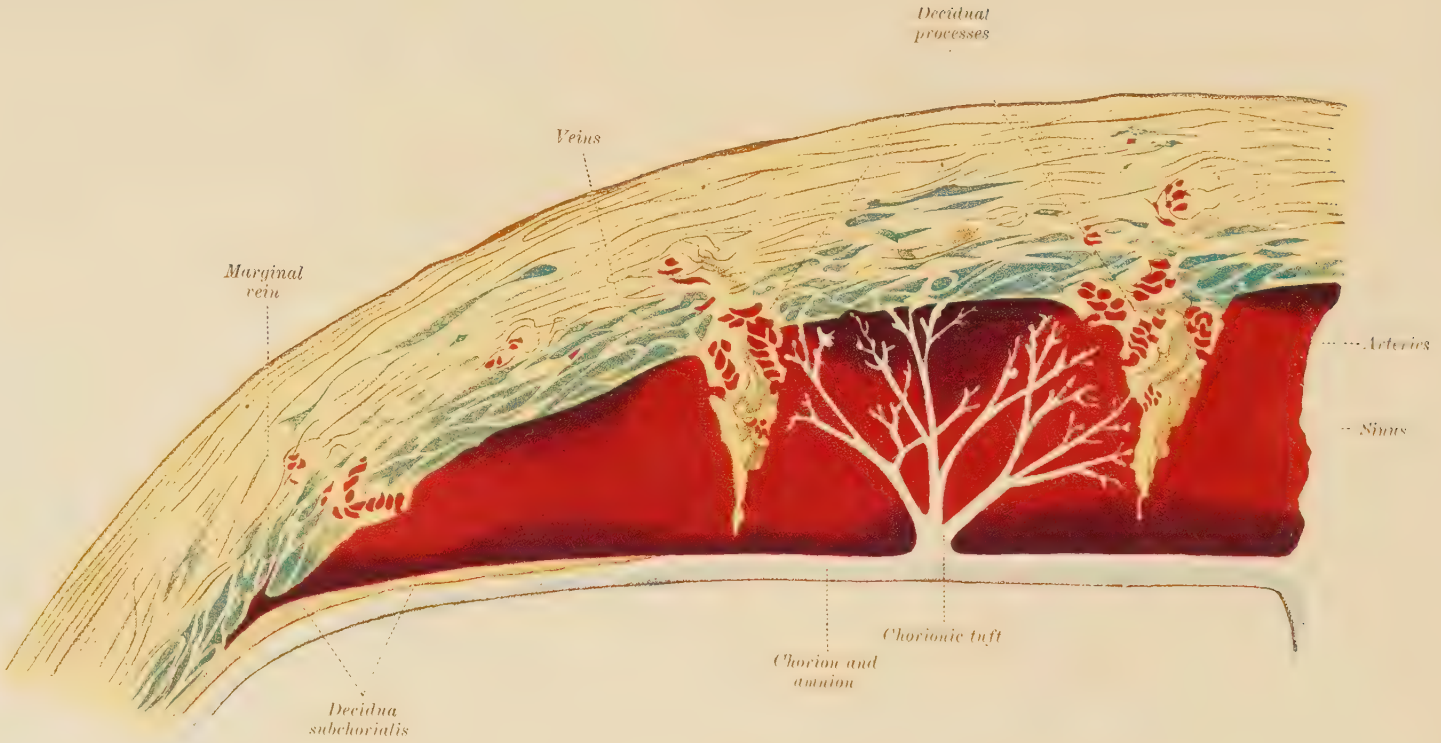
The external or uterine surface of the placenta.

and internal to the arteries. The external portion of the placenta presents a rough and irregular surface which in the recent state is covered with blood and clots. It is broken into asymmetrical patches or squares, the *cotyledons*, between which the decidua serotina dips down forming partitions or septa.

As already pointed out, the caudal end of the embryo is prolonged to the wall of the chorionic vesicle as the abdominal stalk. The latter, therefore, consists of the same structures as the remainder of the embryo, and possesses a rudimentary groove, a somatopleure, and a splanchnopleure. At first the amnion springs from the sides of the stalk.

By the down growth of the two somatopleural leaves and the uniting on their edges on the ventral side of the stalk, a tube is formed, the cavity

PLATE XIII.



Section of Placenta. Uteroplacental Circulation. (After Bumm.)

Section through the Serotina, Ninth Week. (Bumm.)

of which is continuous with the cavity of the cœlom, and within which the allantoic diverticulum and the pedicle of the yolk-sac are imprisoned. As a result of the closing in of the tube, which is hereafter known as the *umbilical cord*, the amnion becomes separated from the abdominal stalk, the separation beginning at the embryonic end and extending to the chorionic attachment. Thus, as has been demonstrated by Minot, the umbilical cord is at no time covered by the amnion. The cavity of the cord becomes obliterated at an early stage, and the allantois and yolk-stalk atrophy and disappear, although it is claimed by some observers (Kölliker, Minot) that the allantois can be distinguished at birth.

At term the cord has been compared to a "twisted rope of tissues," extending from the placenta to the child. The cord is of a glistening grayish-white color, of varying thickness, and is usually about 22 inches long, but may be either much longer or shorter.

In structure the cord consists of a covering of epithelium continuous with that of the amnion, which surrounds a jelly-like matrix called Wharton's jelly. This consists of mucin, branched corpuscles, and embryonic connective-tissue cells. Within this substance the two arteries and one vein run in a spiral course, usually from left to right; it is to the fact that the growth in length of the vessels exceeds that of the rest of the cord that the twisted appearance of the latter is probably due.

Utero-placental Circulation. The most comprehensive explanation of this difficult problem has been advanced by Bumm, whose conclusions may be summarized as follows: The decidua gives rise to numerous processes between which the chorionic villi penetrate. (Plates XIII. and XIV.) The arteries of the processes run in an irregular manner with many spiral turns, and as they approach the surface of a process become tuft-like, and losing their coats open freely into the intervillous spaces. The veins open at the bases of the processes and along the decidual margins of the intervillous spaces. The chorionic villi, therefore, hang more or less freely in a blood-filled sinus. Each decidual process, cotyledon, has its individual circulatory region, the blood pouring out from the sides of the process and re-entering the maternal circuit through the veins at its bottom.

The greater the distance from the decidual process, the slower becomes the blood-current, until a point is reached where absolute stasis occurs with resulting fibrin deposit. The circular sinus at the edge of the placenta receives the blood from the lowest processes, but, as it appears often interrupted, it can have but limited importance in carrying off the blood. The chorionic villi very rarely if ever penetrate into the mouths of the arteries, but they do enter the veins and often for a considerable distance. (Plate XIV.)

The Embryonic and Fœtal Circulation. At a very early period of development the embryonic area presents, on surface view, a netted appearance, due to cord-like thickenings in the splanchnopleural mesoderm. Scattered among these cords are reddish-yellow patches, blood-islands or *islands of Pander*, the cells of which develop hæmoglobin, which gives rise to their color. This reticulated region is called the *area vasculosa*, and it is bounded by a large vessel, the *sinus terminalis*. (Fig. 79.) By a process of liquid vacuolation the mesodermal cords become hollowed out, and acquiring a lumen give rise to the primitive *bloodvessels*.

An extension of the vascular network takes place by the uniting and

anastomosing of bud-like offshoots from the primitive vessels, which extend toward and finally penetrate the embryo, where they unite with the embryonic vessels.

Coincident with the formation of the extra-embryonic circulation, the embryonic heart is developed and begins to pulsate before connection with the vessels has been established.

FIG. 72.

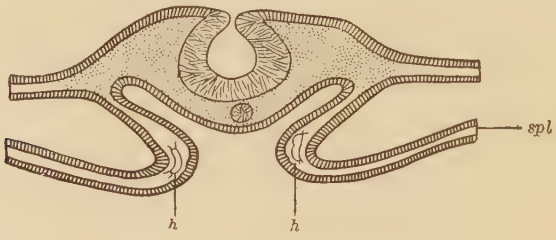


FIG. 73.

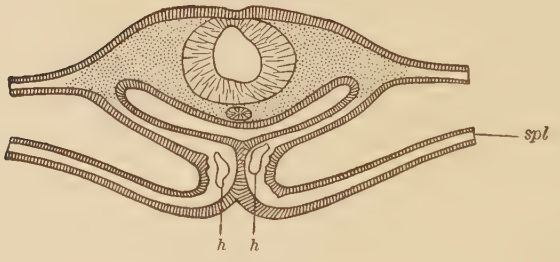
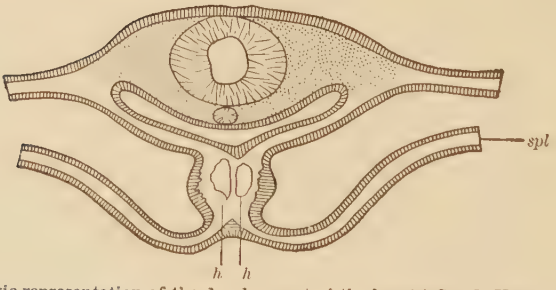


FIG. 74.

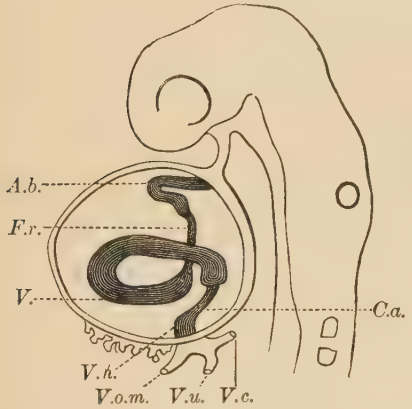


Schematic representation of the development of the heart (after O. HERTWIG).
h. Heart. *spl*. Splanchnopleure.

As the result of splitting of the mesoderm and the folding off of the embryo, the splanchnopleural leaves are forced downward, and, approaching each other, unite in the ventral median line. Before this is accomplished a small cavity makes its appearance in the splanchnic mesoderm of either side in the cephalic region of the embryo. By the down-folding of the splanchnopleure these cavities come to lie ventrad to the future throat, and are gradually brought together, their walls fusing. (Figs. 72 to 74.) These cavities are the proton of the primitive *heart*, which is at the start a double tube. The middle wall of the heart-tube soon disappears, a single cavity resulting. The mesodermal cells of the heart cavity undergo changes which give rise to the endothelial lining of the

completed organ. At first the heart is attached to the surrounding tissues by a ventral and a dorsal mesocardium, but the former and a portion of the latter disappear, leaving the heart projecting freely into

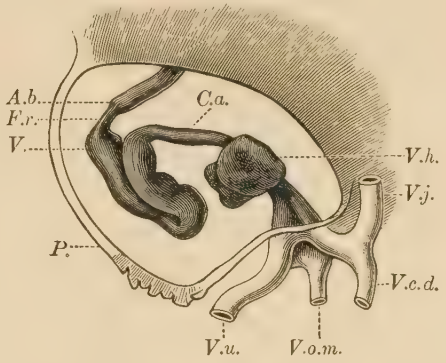
Fig. 75.



Endothelial heart of a human embryo (after His).

A.b. Bulbus aortæ. *F.r.* Fretum Halleri. *V.* Ventricle. *V.h.* Auricle. *V.o.m.* Omphalo-mesenteric vein. *V.u.* Umbilical vein. *V.c.* Vena cava. *C.a.* Auricular canal.

Fig. 76.



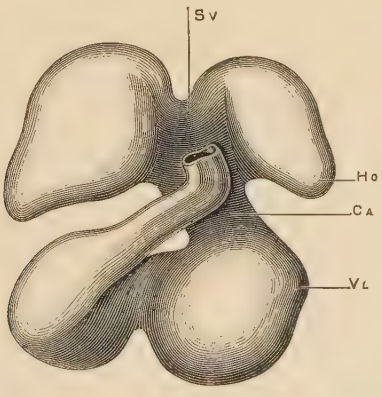
Endothelial heart (after His).

A.b. Bulbus aortæ. *F.r.* Fretum Halleri. *V.* Ventricle. *P.* Wall of pericardium. *V.u.* Umbilical vein. *V.o.m.* Omphalo-mesenteric vein. *V.c.d.* Cardinal vein. *V.j.* Jugular vein. *V.h.* Auricle. *C.a.* Auricular canal.

the cœlomic cavity. The upper end of the heart-tube then dilates into what will be the future *aortic bulb*.

In the further development of the heart the lengthening of the tube in a confined space causes it to assume an S-shaped bend to the right,

Fig. 77.



Endothelial heart of a human embryo (after His).

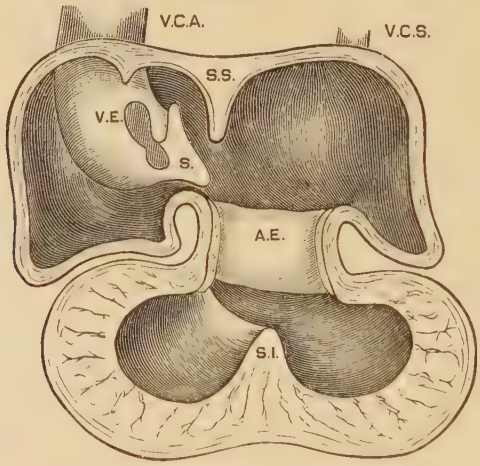
Sv. Sinus venosus. *Ho.* Auricle. *Ca.* Auricular canal. *Vl.* Ventricle.

that portion to the right and in front representing the future ventricles, that to the left and behind the auricles. (Figs. 75 and 76.)

The auricular portions on either side expand and become somewhat constricted off from the ventricle, the opening between the two being the

auricular canal. (Fig. 77.) A partition—the *septum superius*—then develops from above, and growing downward to the auricular canal converts the single auricle into right and left cavities. At a later stage the septum is perforated above, giving rise to the *foramen ovale*, an opening between the auricles which persists until some time after birth. The separation of the ventricles is first indicated by a groove on the exterior of the heart, a *septum inferius* developing from a corresponding point in the interior, and extending nearly upward to the auricular canal, a small foramen remaining open. (Fig. 78.) At the same time a division of the aortic bulb takes place, the septum extending downward to and fusing with the septum inferius. This division of the aortic bulb gives rise to two vascular channels, that to the left and in front becoming the pulmonary artery, while that to the right and behind is the permanent aorta, which has for its opening the interventricular foramen.

FIG. 78.



Inner surface of heart (after HIS).

V.C.S. Superior vena cava. S.S. Septum superius. V.E. Eustachian valve. S. Area interposita. A.E. Auricular canal. S.I. Septum inferius.

Coincident with the development of the heart and the extra-embryonic circulation, bloodvessels have been forming in various parts of the embryo, and with the uniting of these vascular channels a primitive circulation is soon established.

Primitive Embryonic Circulation. (Fig. 79.) The anterior end of the heart prolonged as the *truncus arteriosus* soon divides in the region of the first branchial arch into two primitive aortæ, which run forward and bend around on either side to the dorsum of the embryo, where they continue longitudinally to the caudal end. From the aortæ branches are given off, the chief of which, the *omphalo-mesenteric arteries*, carry most of the blood to the capillaries of the vascular area. The return current from the vascular area is carried by two *omphalo-mesenteric* or vitelline veins. Later each vitelline vein unites with its corresponding umbilical vein and the common trunk joins the Ductus Cuvieri which opens into the venous portion of the heart.

Secondary Embryonic Circulation. *Arteries.* With the development

of the allantois and its union with the chorion, further changes in the circulation take place. The posterior portions of the two primitive aortæ fuse to form a single permanent *dorsal aorta*, from which branches, the *vitelline arteries*, are given off to the yolk-sac, and two terminal vessels—the *allantoic arteries*—which carry the blood from the placenta to the embryo.

FIG. 79.

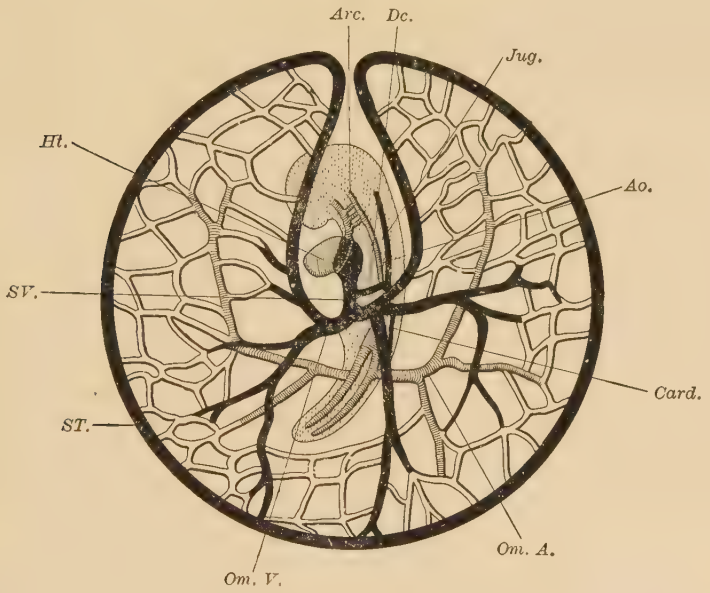


Diagram of the circulation of a chick at the end of the third day, as seen from the under or ventral side (after MINOT).

Ht. Heart. *Arc.* Aortic arches. *Dc.* Ductus Cuvieri. *Jug.* Jugular vein. *Ao.* Aorta. *Card.* Cardinal vein. *Om.A.* Omphalic artery. *Om.V.* Omphalo-mesaraic vein. *ST.* Sinus terminalis. *SV.* Sinus venosus.

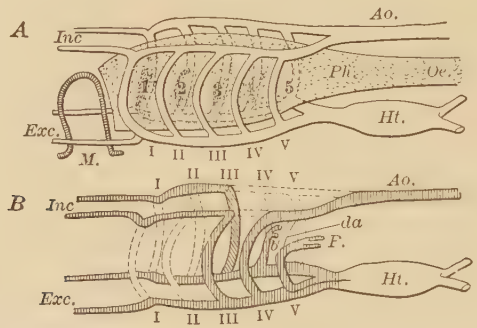
The truncus arteriosus also gives off five paired branches—the *aortic arches*—which run right and left around the visceral arches to the primitive aorta of the corresponding side. (Fig. 80, *A*.)

These arches develop from in front backward, and disappear in the same order, so that the five pairs are never in a state of perfect development at the same time. By the fourth week changes begin to take place in the arches which are indicative of the permanent adult vascular arrangement. From the ventral trunk, anterior to the origin of the third branchial vessel, the *external carotid arteries* arise; the third arch and the dorsal portions of the first and second arches give rise to the *internal carotid*; the ventral portions represent the *common carotids*.

The left fourth arch enlarges, becoming the *permanent aortic arch*, while the right fourth arch becomes distinctly smaller, loses its connection with the aorta, and dividing gives rise to the *vertebral artery* and its branch, the *subclavian*, of the right side. (Fig. 80, *B*.) The left fifth arch gives off the left *pulmonary artery*, which at first communicates with the dorsal aorta through the *ductus arteriosus* (*ductus Botalli*). The right fifth arch disappears above the origin of the pulmonary artery of that side.

The *iliac arteries* arise from the umbilical arteries—the proximal portions of the allantoic arteries—during the development of the posterior extremities. The remainder of the allantoic vessels become the *hypogastric arteries.*

FIG. 80.

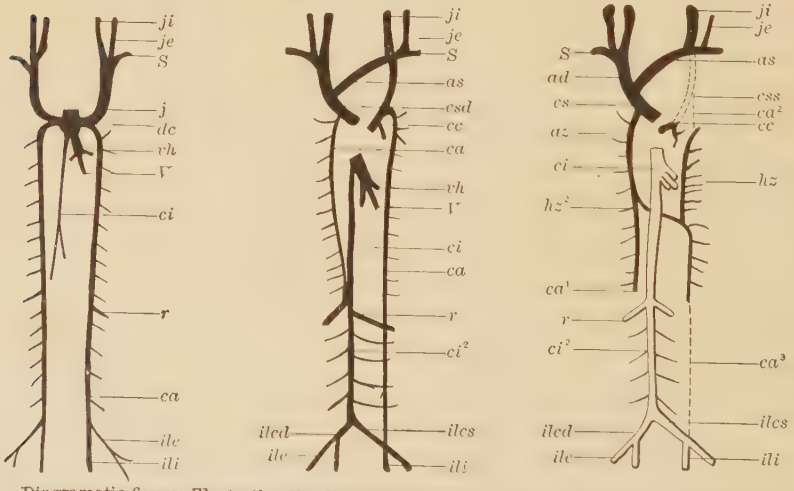


A. Diagram of pharynx of an amniote vertebrate. *B.* Diagram of gill arches as preserved in mammals (after MINOT).

The shaded portions are those which remain, the unshaded those which disappear. *Inc.* Internal carotid. *Ao.* Aorta. *Ph.* Pharynx. *Oe.* Œsophagus. *Ht.* Heart. *Exc.* External carotid. *M.* Mouth invagination. 1, 2, 3, 4, 5. Gill pouches (clefts). I, II, III, IV, V. Aortic arches. *da.* Ductus arteriosus. *P.* Pulmonary artery.

Veins. The blood is returned to the heart by four sets of vessels: the *jugular*, the *cardinal*, the *vitelline*, and the *umbilical* veins. The two jugulars receive the blood from the head, the two cardinals from the trunk, and both unite to form the *ducts of Cuvier*, which enter the heart

FIG. 81.



Diagramatic figures illustrating the development of the venous system (after O. HERTWIG).

dc. Ductus Cuvieri. *je, ji.* External and internal jugular veins. *S.* Subclavian vein. *vh.* Hepatic vein. *V.* Umbilical vein. *ci, ci².* Vena cava inferior. *ca, ca¹, ca², ca³.* Cardinal vein. *ilcd.* Right and left common iliac veins. *ad, as.* Right and left brachio-cephalic veins. *cs.* Vena cava superior. *cc.* Coronary vein. *az.* Azygos vein. *hz, hz².* Hemiazygos vein. *ile.* External iliac. *ili.* Internal iliac. *r.* Renal vein.

by the *sinus venosus*. At a later period the right Cuvier's duct becomes the *superior vena cava ;* the left duct disappears.

The cardinals are in intimate relation with the Wolffian bodies, and on the resorption of the latter a middle part of the left cardinal disappears, its anterior portion becoming the *hemiazygos vein*. The right cardinal gives rise to the *azygos vein*, and the posterior portions of both cardinals to the *internal iliac veins*. (Fig. 81.)

The blood is returned to the yolk-sac by the two vitelline veins, which enter the embryo at the umbilicus, run cephalad along the splanchnopleural mesoderm beside the primitive gut, and empty into the *sinus venosus*.

In the hepatic region the vitellines are united by three transverse branches, and, after forming two vascular rings around the duodenal portion of the gut, break up into smaller vessels which enter the liver. These vessels are afferent, carrying the blood to the liver, where a capillary network is established; they later become (Fig. 82) branches of the

FIG. 82.

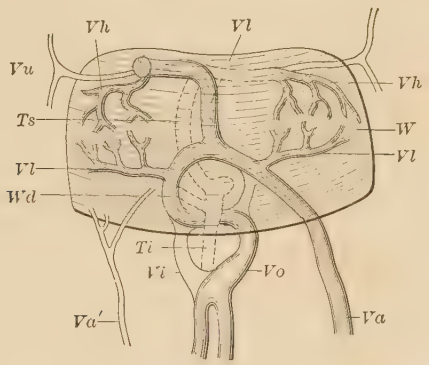


Diagram of the liver veins (after His).

Ts. Stomach. *Va'.* Right allantoic vein. *Vl.* Ductus venosus or vena Arantii. *Vh.* Efferent hepatic vessel. *Vl.* Afferent hepatic vessel. *Vo.* Portal vein. *Vi.* Vitelline vein. *W.* Liver. *Wd.* Bile duct. *Va.* Left allantoic vein. *Ti.* Intestine. *Vu.* The white vessels represent those which are aborted.

portal vein. From the capillary network the blood is collected by efferent vessels which carry it to the heart; these vessels become the *hepatic veins*. At a later period the *portal vein* is developed from the two vascular rings, the right side of the upper ring and the left side of the lower ring disappearing, a single vessel remaining, which makes a spiral turn around the intestine.

In the allantoic stalk the two umbilical veins fuse, forming a single vessel, which again separates within the embryo and, running in the somatopleure to the liver, empties into the duct of Cuvier. After a time the right umbilical vein dwindles and breaks up into several branches, some of which join the efferent hepatic veins as they leave the liver, while the remainder disappear. The left umbilical vein enlarges and joins the portal vein just as this vessel enters the liver.

When the vitelline and umbilical veins lose their direct connection with the heart—on account of the intercalation of the hepatic circulation—the liver soon becomes unable to accomodate the increasing

quantity of blood which passes through it, so that a communicating vessel is formed which connects the portal vein, just before it enters the liver, with the right hepatic vein just before it terminates in the sinus venosus. This is the *ductus venosus*, and through it the greater quantity of blood is carried directly to the heart without having to traverse the liver capillaries.

The *vena cava inferior* is developed as a small vessel from the ductus venosus, and runs through the liver caudad between the kidneys to terminate in the *iliac veins*.

The *pulmonary vein* at first empties into the left auricle by a single opening, but about the fourth month two or three mouths have developed and remain permanent.

The Blood. The primitive red cells are derived from the endothelial lining of the vessels and from the blood-islands. According to Minot, they are at first spherical, the nucleus is large, and they are surrounded by a layer of protoplasm. They multiply by indirect division. Before the formation of the lymph-glands little is known regarding the origin of the white blood-cells.

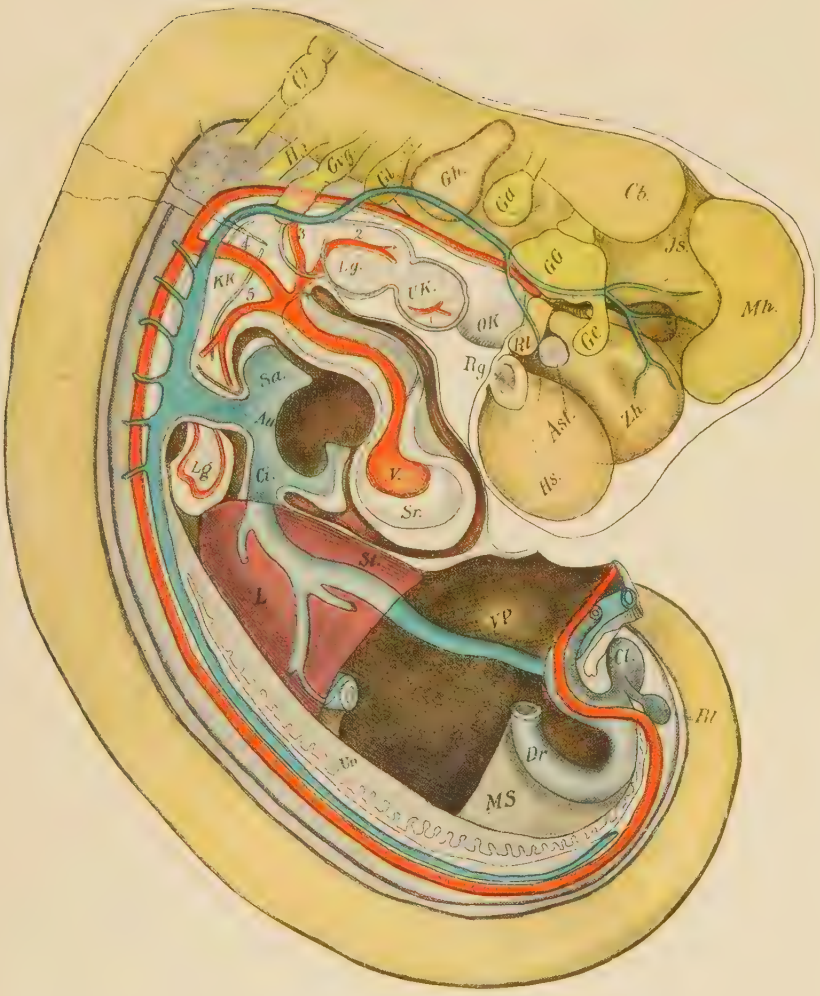
The Embryonic Circulation. In the primitive or vitelline circulation the blood is collected from the vascular area by the vitelline or omphalo-mesenteric veins, which empty into the sinus venosus. This also receives the blood from the systemic veins, and opens into the primitive cardiac auricle. From the ventricle the blood passes through the truncus arteriosus and the aortic arches to the primitive aortæ, whence it is returned through the vitelline or omphalo-mesenteric arteries to the vascular area, and to a limited extent to the body of the embryo.

Following the development of the allantois and the placenta the circulation becomes more complex. (Plate XV.)

The blood is carried from the placenta by the single umbilical vein to the under surface of the liver, where it divides into two streams, one proceeding through the ductus venosus to the inferior vena cava, and thence to the right auricle of the heart; the other, being joined by blood from the portal vein, passes through the capillaries of the liver, and so on through the hepatic veins to the inferior vena cava and the right cardiac auricle. From the right auricle the blood is directed by a fold —the *Eustachian valve*—through the *foramen ovale* to the left auricle. Here it meets with the current from the pulmonary veins, and is passed through the auricular-ventricular opening into the left ventricle, and thence to the aorta and the branches of the systemic vessels. From the head and upper extremities the blood is collected by the superior vena cava and, passing directly through the right auricle, enters the right ventricle, by which it is forced into the pulmonary artery. Just outside the lungs, however, the stream divides, a small portion only going to these organs, the greater part turning off through the ductus arteriosus to the aorta. From the aorta most of the blood passes through the hypogastric arteries back to the placenta, a small amount going to the lower portion of the embryonic body and extremities. (Plate XVI., A.)

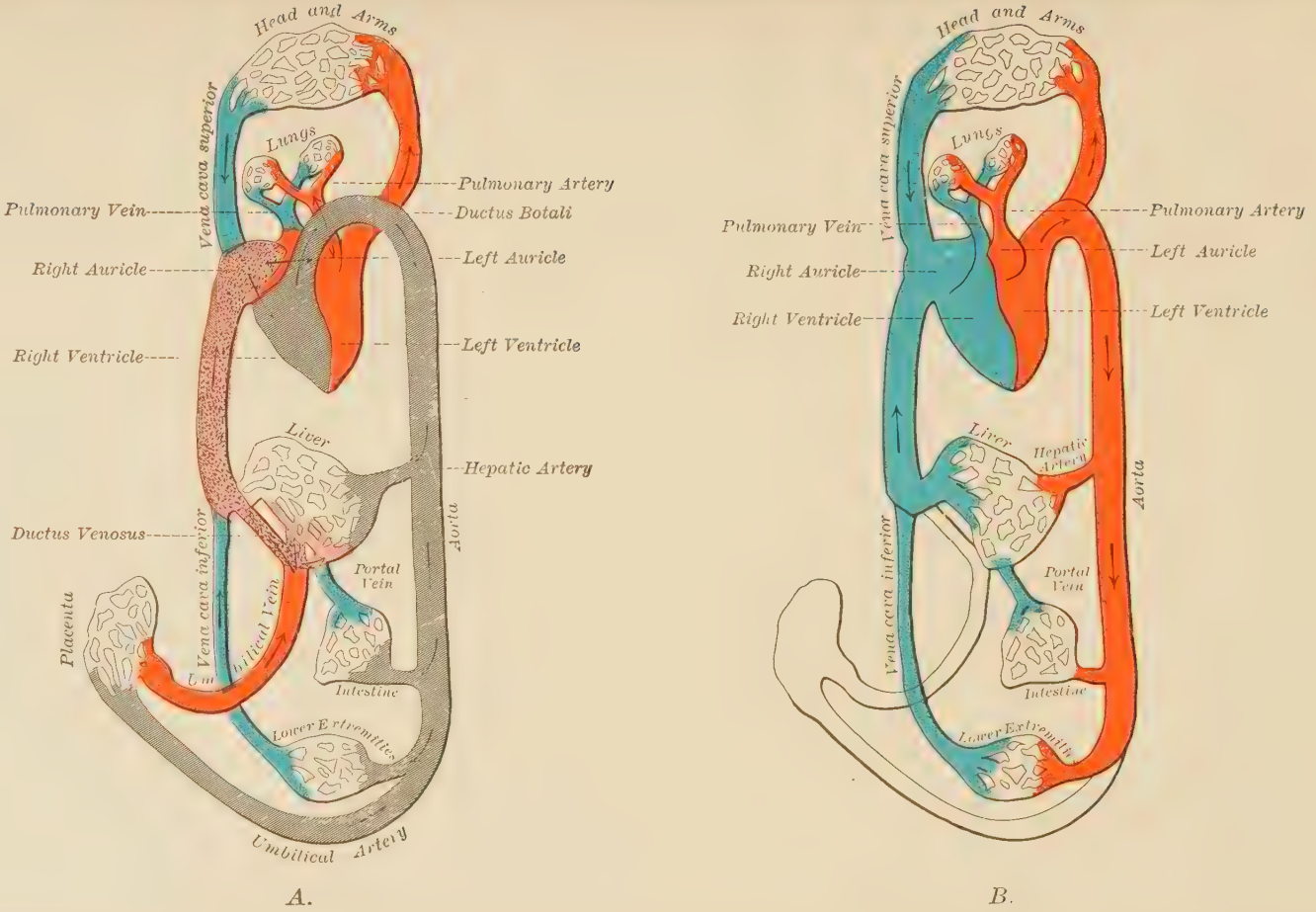
Changes in Circulation at Birth. By the third or fourth day after birth the hypogastric arteries have dwindled and become obliterated; by the end of the first week the umbilical vein and the ductus venosus are closed; and by the end of the third week the ductus arteriosus has become impervious. The foramen ovale usually closes soon after birth,

PLATE XV.



Diagrammatic Representation of a Human Embryo estimated as about Four Weeks Old, showing Heart, Bloodvessels, Brain, and Abdominal Viscera. (Modified from His.)

Hs, hemispheres; *Ast*, optic stalk; *Zh*, between brain; *Mh*, mid-brain; *Js*, isthmus of hind-brain; *Cb*, cerebellum; *Gc*, ciliary ganglion; *El*, olfactory lobe; *Rg*, nasal pit; *GG*, Gasserian ganglion; *Ga*, ganglion of auditory nerve; *Gh*, auditory vesicle; *Gl*, ganglion of glossopharyngeal nerve; *Gvg*, ganglion of vagus nerve; *Hp*, hypoglossal nerve; *Ci*, ganglion of first cervical nerve; *Ok*, superior maxilla; *UK*, inferior maxilla; *Lg*, tongue; *KK*, larynx; *Sa*, septum atrium; *Sv*, septum ventriculorum; *C*, internal carotid; *Lg*, lung; *L*, liver; *St*, septum transversum; *Vp*, vena portæ; *Un*, Wolffian bodies; *Ms*, mesentery; *Dr*, intestine; *Cl*, cloaca; *Bl*, kidney proton; *V*, ventricle; *Au*, auricle. The dorsal aorta and internal carotid arteries are indicated in light red; the cardinal and jugular veins are in blue.



A.—Diagram of Fetal Circulation Before Birth. (Modified from Hasse.)

but it may remain patent as a diminutive aperture during the first year, or even throughout life. A persistent opening of the foramen results in an admixture of the venous and arterial blood in the auricles, which gives rise to a general blueness of the surface of the body, a condition known in the infant as *cyanosis neonatorum*, and in the adult as *morbus ceruleus*.

As the result of the obliteration of the vessels mentioned the blood from the cava, superior and inferior, passes from the right auricle to the right ventricle, from by the pulmonary artery to the lungs, from which it is returned by the pulmonary veins to the left auricle, and so on to the left ventricle, by which it is forced into the dorsal aorta and distributed to the trunk, head, and extremities. The adult circulation is thus established. (Plate XVI., *B*.)

The Lymphatic System. In mammalian embryos (Fig. 82) a pair of lymph breasts appear, one on either side, at the junction of the subclavian and jugular veins. From the left lymph breast the *thoracic duct* is developed, and is at first bifurcated. A second pair of lymph breasts then appear at the junction of the sciatic and cardinal veins, but at a later period lose their connection with the veins and join the vessels from the thoracic duct. Lymph nodes arise in the lymphatic network as masses of cells which soon take on the appearance of adenoid tissue.

The Central Nervous System. Before the closure of the cephalic end of the neural canal has taken place, the beginning of the future brain is indicated. (Fig. 83.)

FIG. 83.

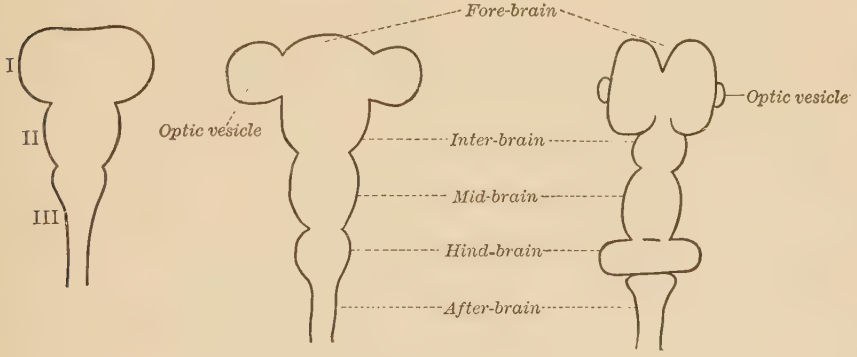


Diagram showing formation of brain (after BONNET).
I–III. Primary cerebral vesicles.

The anterior end of the medullary tube enlarges, and at two points its walls become constricted, giving rise to three communicating cavities, the *primary cerebral vesicles*, known as the *fore-brain*, *mid-brain*, and *hind-brain*. At about the same time that the cerebral vesicles are forming, the cephalic portion of the neural tube becomes bent as the result of the unequal growth of the parts. (Fig. 84.) The first of the cerebral flexures—the *primary head-bend*—takes place in the region of the mid-brain, the fore-brain being forced ventrad so that it comes to lie at a right angle to the mid-brain, the latter being carried forward and upward to the top of the head. The second, or *neck-bend*, occurs at the union of the hind-brain and the spinal cord, the whole head being

thereby thrown further forward and downward, so that the floors of the fore- and hind-brains become parallel. The third bend—the *varolian bend*—affects the hind-brain, and consists in a forward growth of this vesicle.

With the beginning expansion of the fore-brain two lateral outgrowths —the *optic vesicles*—make their appearance. These soon become partially constricted off from the fore-brain, their narrow pedicles—the *optic stalks*—being the prota of the optic nerves. The dorsal wall of the fore-brain continues to grow forward and upward from the rest of the vesicle, and soon forms a fourth ventricle or *permanent fore-brain*, the proton of

FIG. 84.

Brain of human embryo of five weeks, illustrating cerebral flexures (after HIS).

H. Hemisphere. *Mb.* Mid-brain. *Hb.* Hind-brain. *R.* Olfactory lobe. *OP.* Optic nerve. *Sp.c.* Spinal cord.

the *cerebral hemispheres*. (Fig. 85.) The original portion of fore-brain is now called the *inter-brain;* its cavity becomes the *third ventricle* of the adult brain, while the opening between it and the permanent fore-brain is the future *foramen of Monro*.

FIG. 85.

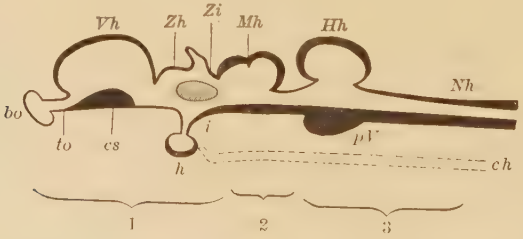
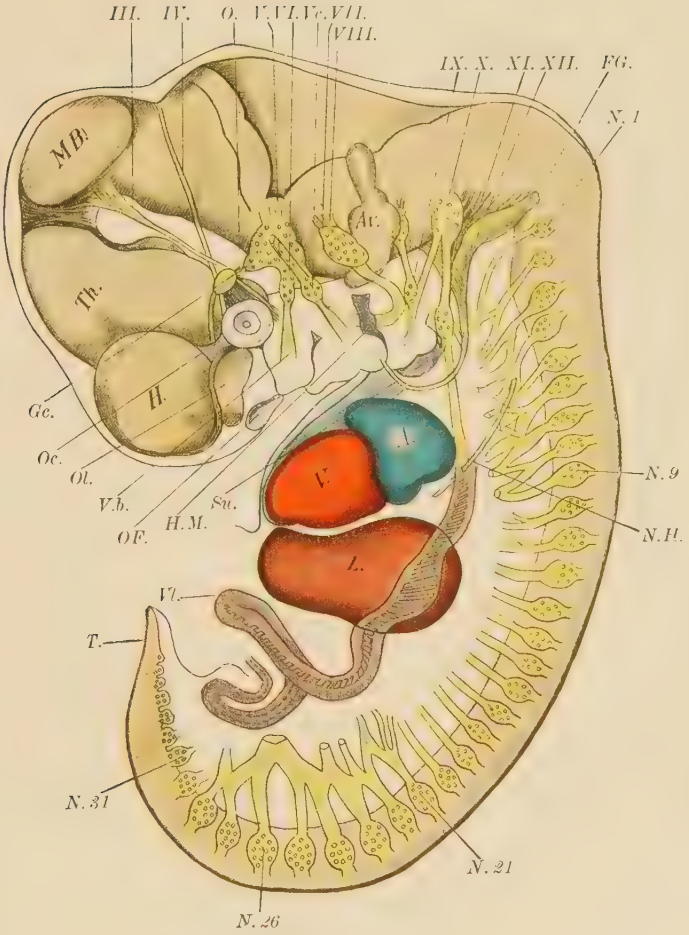


Diagram to illustrate the formation of the primitive brain (after BONNET).

bo. Olfactory bulb. *Vh.* Secondary or permanent fore-brain. *Zh.* Inter-brain. *Zi.* Epiphyses. *i.* Infundibulum. *h.* Hypophysis. *Mh.* Mid-brain. *Hh* Hind brain. *Nh.* Medulla or after-brain. *pV.* Pons Varolii. *to.* Olfactory tract. *cs.* Corpus striatum. *ch.* Chorda dorsalis. 1, 2, 3 correspond to the three primitive cerebral vesicles.

The second cerebral vesicle, mid-brain, develops more slowly than the other portions of the brain, which soon overgrow it, forcing it downward and backward. Its walls gradually thicken, while the cavity remains practically unchanged as the *aqueduct of Sylvius*. From the roof of the mid-brain the *corpora quadrigemina* are developed, and in connection with its floor the *crura cerebri*.

PLATE XVII.



Diagrammatic Representation of a Human Embryo estimated as Thirty-one Days Old, showing Brain, Spinal Cord, and Nerves. (Modified from His.)

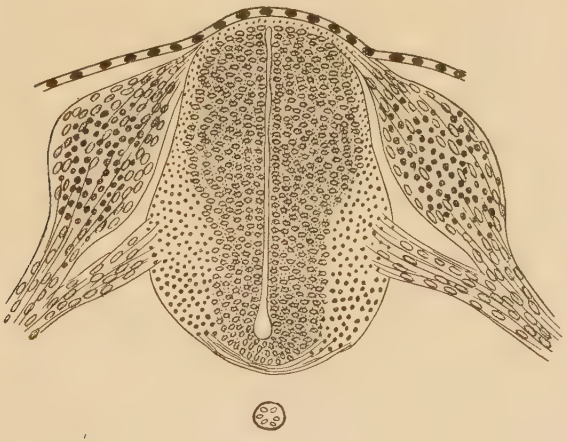
H, cerebral hemispheres; *Th*, thalamencephalon; *MB*, mid-brain; *Su*, sinus precervicalis; *HM*, hyomandibular cleft (external auditory meatus); *OF*, olfactory pit; *Vb*, maxillary branch of fifth nerve (trigeminal); *Ol*, olfactory lobe; *Oc*, optic cup; *Gc*, ciliary ganglion; *III*, third cranial nerve; *IV*, fourth cranial nerve; *O*, ophthalmic branch of fifth nerve; *V*, Gasserian ganglion; *Vc*, mandibular branch of fifth nerve; *VII*, ganglion of seventh nerve (facial); *VIII*, ganglion of eighth nerve (auditory); *Av*, auditory vesicle; *IX*, ninth nerve (glossopharyngeal); *X*, ganglion of root of tenth nerve (pneumogastric); *XI*, roots of eleventh nerve (spinal accessory); *XII*, roots of twelfth nerve (hypoglossal); *FG*, Froriep's ganglion; *N* 1, ganglion of first cervical nerve; *N* 9, ganglion of first thoracic nerve; *NH*, phrenic nerve; *N* 21, ganglion of first lumbar nerve; *N* 26, ganglion of first sacral nerve; *N* 31, ganglion of first coccygeal nerve; *T*, tail; *Vl*, vitelline loop of intestine; *L*, liver; *V*, ventricle; *A*, auricle.

The hind-brain, which at the time of the cerebral flexures is the longest part of the brain, soon becomes differentiated into two parts, an anterior, from the roof of which is developed the *cerebellum*, and from the apex of the floor (varolian bend) the *pons Varolii;* and a posterior portion, from the thickened floor of which, between the pons and the spinal cord, arises the *medulla oblongata*. The cavity of the hind-brain becomes the *fourth ventricle* of the adult brain. As the result of growth and local thickenings the various parts of the brain become differentiated from these primary structures.

The Spinal Cord. The neural canal is at first a simple tube with ectodermal walls. (Plate XII., *N*, Figs. 6, 8, and 9.) In the development of the spinal cord the sides of the tube become thickened, but the dorsal and ventral portions remain thin. The central lumen thus becomes narrowed. At a late period the sides are differentiated into the *anterior*, *lateral*, and *posterior columns* of the cord. The *anterior median fissure* is developed by the forward growth of the ventral portions of the cord, while the *posterior median fissure* represents the obliterated posterior end of the central canal.

Up to the fourth month the cord equals in length the vertebral column, and extends from the first cervical to the last caudal vertebra. (Plate XVII.) From this time on, however, the bony structures outgrow the cord, which appears shortened, and its lower end is drawn out into a fine filament—the *filum terminale*. By the sixth month the cord extends only to the sacral canal; at birth it is at the third lumbar vertebra, while a year later it is at the first lumbar vertebra, where it remains.

FIG. 86.



Transection through the spinal cord of a twenty-two days old sheep embryo (after BONNET).

The cord at first consists of gray matter, but with the development of the nerve-fibres, the white matter appears as a differentiation of the external cell-layer of the cord.

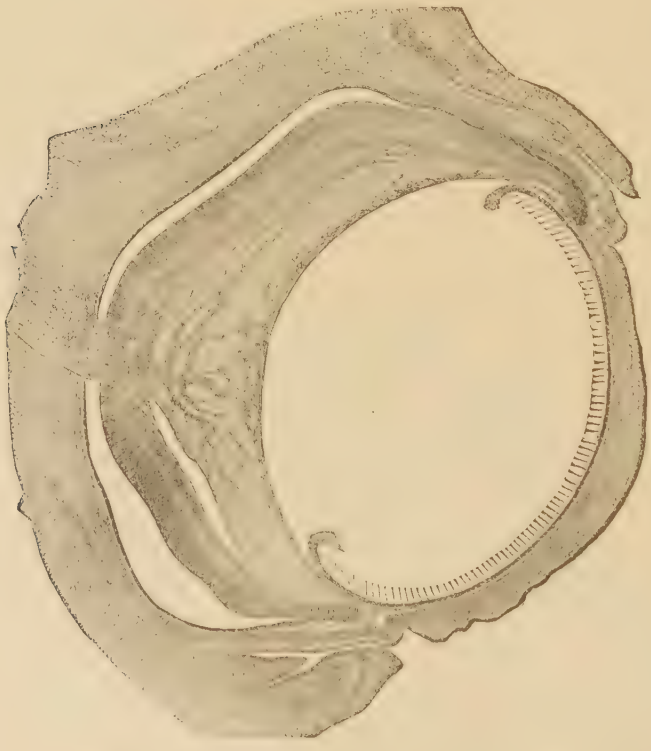
Two sets of nerve-fibres develop from the cord: motor fibres from the nerve-cells of the inner layer, and sensory fibres from the spinal ganglia. (Fig. 86.) The most rapid growth in the nerves takes place in the neck region, where they arise from the cord at right angles. Lower down, as

the result of the superior growth of the vertebral column, the nerves gradually assume a vertical direction, and remain for some distance within the spinal canal before making their exit. The lower bundle of nerves surrounding the filum terminale thus presents a brush-like appearance; this has given rise to the name *cauda equina*.

FIG. 87.

Diagrams illustrating the formation of the optic cups and lens. (KÖLLIKER after REMAK.)

FIG. 88.



Section through the eye of a calf embryo. (After KÖLLIKER.)

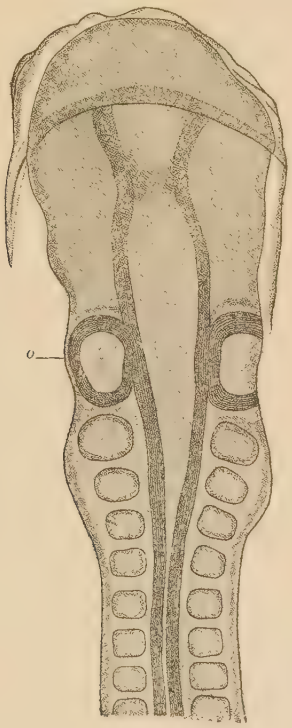
Organs of Special Sense. *The Eye.* The development of the optic vesicles as outgrowths of the fore-brain has already been described (see Fig. 83). When the vesicles reach the ectoderm a close attachment is formed between the two, and the walls of each increase in thickness at the point of contact. The ectoderm then becomes invaginated, forming the *primary optic cup*, the invagination continuing until a vesicle has

become constricted off the proton of the *lens*. (Fig. 87.) In front of the lens-sac the edges of the ectoderm unite and, together with the mesoderm, which has grown in between the lens and the ectoderm, form the proton of the *cornea*. (Fig. 87.) As the result of the invagination of the ectoderm, the wall of the optic vesicle is also pushed inward, forming a *secondary optic cup*, the doubled-in wall of which unites with the posterior wall of the optic vesicle to form the *retina*, the posterior layer of the wall furnishing the future *pigmented layer*.

The space between the retina and the lens develops the *vitreous humor*, while by the splitting of the mesoderm between the lens and the ectoderm the *anterior chamber* of the eye is formed, and later becomes filled with *aqueous humor*.

The tissues about the optic vesicle thicken into a capsule which ulti-

FIG. 89.



Embryo of second day, showing otic pit (*o*). (After KÖLLIKER.)

mately becomes the *sclera* and the *choroid*. The opening of the secondary optic cup is filled by the lens, the edges of the cup giving rise to the *iris*, while the central aperture becomes the *pupil*.

The doubling in of the optic vesicle extends also to the stalk, along the ventral side of which a groove is formed, the *choroidal fissure*. This fissure closes about the seventh week by the fusing of its lips, but before this has taken place, an artery—the *arteria centralis retinæ*—has made its way along the groove, penetrated the vitreous humor, and sent off branches to the lens. The anterior portion of the artery becomes oblit-

erated during the last month of fœtal life. The optic stalk is after a time converted into a solid rod, which acquires nerve-fibres from both the brain and the retina, and becomes the *optic nerve*.

FIG. 90.

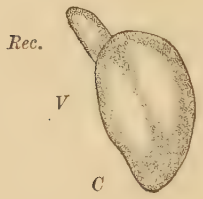


FIG. 91.

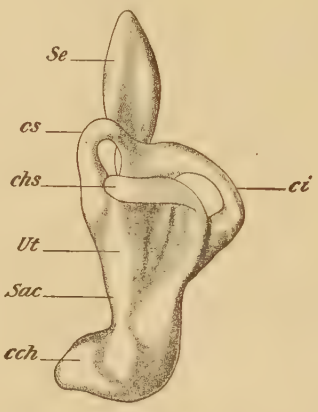
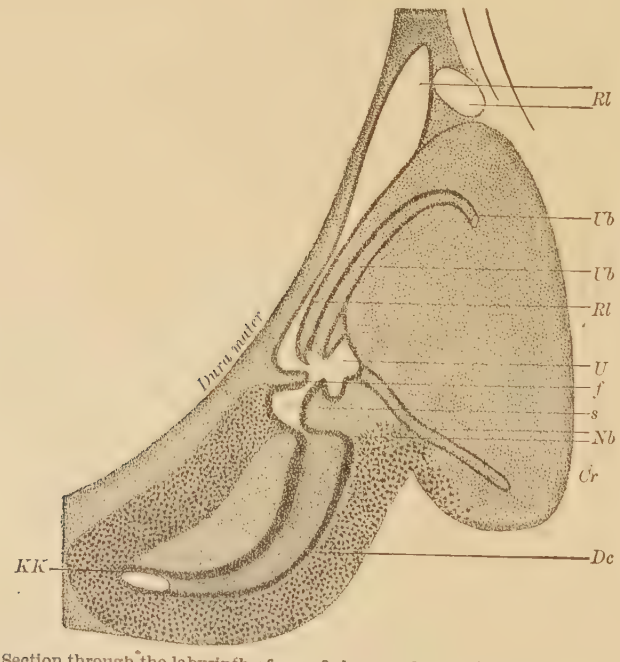


FIG. 90.—Left otocyst of a human embryo of about four weeks. (MINOT after W. HIS, JR.)
Rec. Recessus vestibuli. *V.* Vestibular region. *C.* Cochlea region.

FIG. 91.—Left otocyst of a human embryo of about five weeks. (MINOT after W. HIS, JR.)
Se. Saccus endolymphaticus. *cs.* Upper. *ci.* Lower. *chs.* Horizontal semicircular canal. *Ut.* Utriculus. *Sac.* Sacculus. *cch.* Cochlea.

FIG. 92.



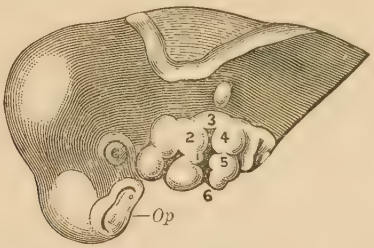
Section through the labyrinth of ear of sheep embryo. (After BÖTTCHER.)
Rl. Recessus labyrinthi; vertical and horizontal canals *U.* Utriculus. *s.* Sacculus.
Cr. Canalis reuniens. *Dc.* Ductus cochlearis. *KK.* Cartilage.

The eyelids arise early as upper and lower folds of integument in front of the eye. The edges of the lids grow toward each other, meet and fuse, but again become separated shortly before birth.

The Ear. The development of the ear differs from that of the eye in that it is an ectodermal structure entirely separated from the brain.

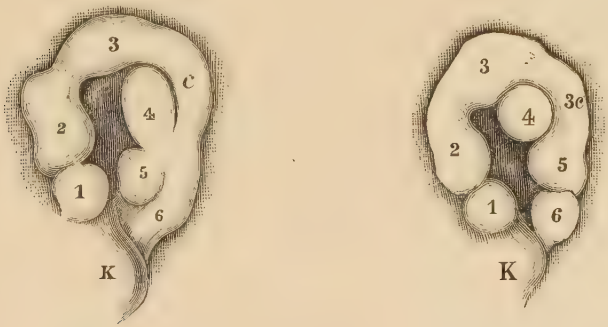
Internal Ear. The first indication of the ear appears about the fifteenth day as a thickening of the ectoderm just above the first gill-cleft. (Fig. 89.) By invagination of this thickened patch a sac is formed, the *auditory vesicle* or *otocyst*, which grows inward and becomes entirely separated from the ectoderm. At first the otocyst is spherical in form, but it soon becomes pear-shaped (Fig. 90) as the result of the development of a projection, the *recessus labyrinthi*, from its dorsal side. By the sixth week the otocyst has been converted by a fold into two portions—a dorsal part—the *utriculus*, from which three projections arise, the prota

FIG. 93.



Development of external ear. (After HIS.) The figures refer to the auditory tubercles.

FIG. 94.



Development of the human external ear. (After HIS.)
1. Tragus. 2, 3, *c*. Helix. 4. Anthelix. 5. Antitragus. 6. Tenia lobularis.

of the *semicircular canals* (Fig. 91), and a ventral part, the *sacculus*, from the anterior end of which the *cochlea* is developed.

The lower proximal portion of the recessus labyrinthi is also converted into two tubes, which open into the sacculus and the utriculus respectively. (Fig. 92.) The complicated specialized portions of the internal ear arise as differentiations of the ectodermal lining of the structures.

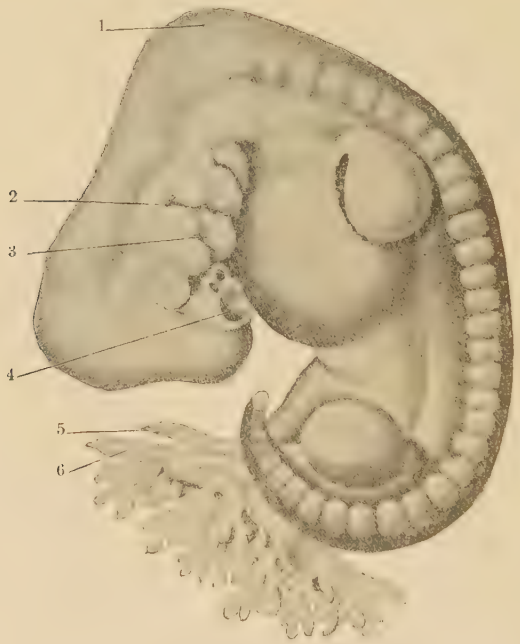
Middle Ear. The *tympanum* is developed from the membrane closing the first gill-cleft (*hyomandibular pouch*); the part within giving rise to the *Eustachian* tube and the *tympanic cavity*, which are lined by entoderm, the part without, to the external auditory meatus, being lined by ectoderm.

External Ear. This is developed from six auditory tubercles which

appear about the external meatus, two from the posterior edge of the first branchial arch, one intermediate, and three behind the first gill-cleft. (Fig. 93.) The first tubercle becomes the *tragus*, the second and intermediate fuse to form the *helix*, the fourth gives rise to the *anthelix*, the fifth to the *antitragus*, and the sixth to the *lobe*. (Fig. 94.) Very little is known regarding the development of the tactile sense; the other two organs of special sense will be described elsewhere.

The Alimentary Tract. From the three portions of the primitive enteron already mentioned are developed the pharynx, œsophagus, stomach, and intestines, and in connection with them the lungs, liver, and other thoracic and abdominal organs.

FIG. 95.



Embryo of four weeks. (HIS.)

1. Cervical spine. 2. Gills (aural opening). 3. Mouth fissure. 4. Nostrils. 5. Amnion. 6. Chorion and villi.

The Mouth. In the development of the mesoderm a space, the proamnion (Fig. 59), is left in front of the head end of the embryo in which no mesoderm appears, the ectoderm and entoderm being closely united at this point. By the formation of the cephalic fold and the bending of the head, this point of union of the two layers, known as the *oral plate*, is carried downward to the ventral side of the head, and comes to lie at the anterior end of the fore-gut, occupying all that space between the fore-brain and the heart. The forward growth of both the fore-brain and the heart gives rise to a depression or pit between them, at the bottom of which lies the oral plate. (Plate XII., Fig. 7, *m*.) The sides of the depression are formed by a layer of somatopleure which extends from heart to head, and afterward gives rise to the cheeks.

By the rupture of the oral plate a direct communication between the pit or oral cavity and the fore-gut is established.

The Pharynx. The anterior portion of the fore-gut, which from the first is the widest part of the primitive enteron, still further dilates at its distal end, thus converting the tubular canal into a funnel-shaped cavity, the future pharynx. This portion of the primitive gut has no cœlomic cavity.

At the beginning of the third week the entoderm of the sides of the pharynx develops a series of four paired pouches, the *branchial, visceral,* or *gill-clefts* (Fig. 95), which grow outward to the ectoderm and unite with it. The anterior pair of gill-clefts appear at about the level of the mouth, and are followed by the other three pairs in regular order. Meanwhile the tissues from the three primary layers along the sides of

FIG. 96.

FIG. 97.

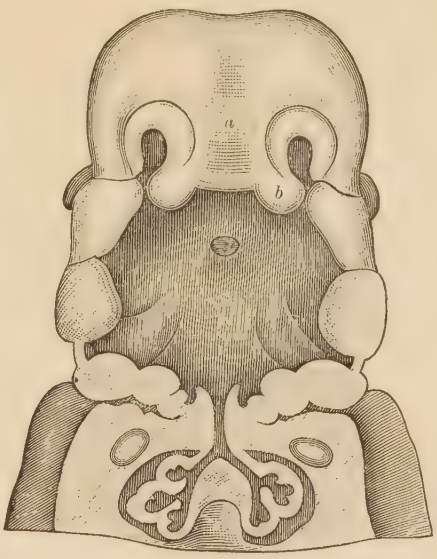


FIG. 96.—Frontal construction of the mouth and pharynx. (After His.)

FIG. 97.—Frontal construction of the mouth and pharynx, showing development of nose and lungs. (After His.)

the pharynx develop into five ridges between the clefts—the *branchial, visceral,* or *gill-arches,* which project quite freely from the surface both internally and externally. (Figs. 96 and 97.)

The first visceral, or mandibular, arch, as it is afterward called, forms the lower boundary of the mouth, and is developed into the *inferior maxilla.* From this arch a process, called the *maxillary process,* is given off on either side, and these processes uniting at their distal ends form the upper boundary of the mouth. The second and third arches give rise to the *hyoid* and *thyro-hyoid bones;* the fourth and fifth arches have no particular significance, eventually disappearing.

From the first gill-cleft are developed the *Eustachian tube* and the *tympanic cavity;* from the second the *tonsils;* while the third and fourth clefts are concerned in the formation of the *thymus* and *thyroid glands.*

The Nose. At an early stage a thickening of a patch of ectoderm in contact with the fore-brain and lying cephalad to the mouth gives rise to the *olfactory plates.* (Fig. 93, *Op.*) By an upgrowth of the ectoderm and mesoderm around the plates they are converted into the *nasal pits,* the lower sides of which remain open as a groove communicating with the mouth cavity. A tongue of tissue—the *nasal process* (Fig. 97, *a*)—now develops from the anterior wall of the head, and as it grows downward toward the mouth sends out on either side a rounded protuberance, the *processus globulari* (Fig. 97, *b*), which unites with the maxillary process. The nasal grooves are thus converted into canals, the *posterior nasal passages,* leading from the pits to the mouth. Later the nasal pits become the narrow, slit-like apertures of the anterior nares. The *alæ nasi* arise from the growth of the lateral margins of the pits. The *Schneiderian membrane* is evolved from the epithelium of the olfactory

FIG. 98.

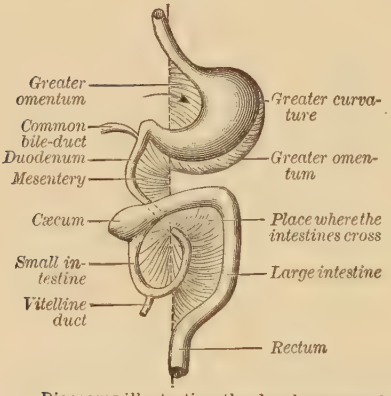
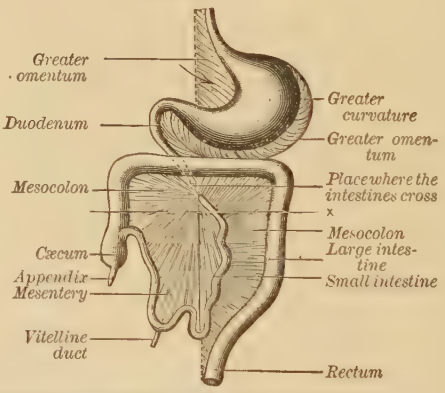


FIG. 99.



Diagrams illustrating the development of the stomach, intestine, omentum, and mesentery. (After O. HERTWIG.)

plates, and at a later period is brought into relation with the olfactory lobes of the brain by means of ganglia which develop from its epithelium.

The Tongue. The anterior portion of the tongue arises as a small tubercle in the median line on the floor of the pharynx, between the ends of the first and second arches, the ends of the second and third arches fusing to form the proton of the back of the organ. The lingual epithelium is of ectodermal origin; the papillæ develop late, and from them the taste-bulbs.

The œsophagus is that part of the fore-gut lying between the pharynx and the stomach. During the fourth week, as the neck elongates the œsophagus is rapidly stretched out to a considerable length, but it still retains its cylindrical form.

The stomach appears during the fifth or sixth day as a slight dilatation of the primitive enteron between the œsophagus and the liver. (Figs. 102 and 103.) It soon shifts its position to below the liver. During the fifth week it becomes more pyriform in shape, and assumes a transverse position in the body, its left side coming to the front, while its right side is turned backward. During the change in position of the stomach its attachment to the dorsal body-wall becomes stretched out as a thin membrane—the *mesogastrium*—which, as the stomach rotates, forms a double

fold, that part of the membrane along the greater curvature of the stomach giving rise to the *greater omentum*, while that from the smaller curvature becomes the *lesser omentum*. (Figs. 98 and 99.)

The *intestine* includes all of the alimentary canal between the stomach and the anus. At first it is a straight tube, but as the result of rapid growth it soon becomes coiled in order to accommodate its increasing length within the abdominal cavity. A duodenal loop (Fig. 100) is formed just below the stomach, and lower down a vitelline loop, which is in connection with the yolk-sac, appears. The lower portion of the intestinal canal enlarges and grows more rapidly than the upper part and forms the large intestine. The cæcum appears about the fifth week as a protrusion from the distal portion of the vitelline loop near the yolk-stalk, and from it the *vermiform appendix* develops as a long and slender outgrowth. (Fig. 99.) The posterior end of the intestine

FIG. 100.

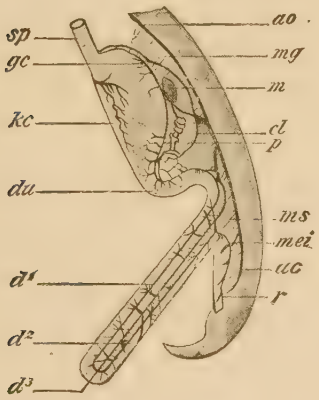


FIG. 101.

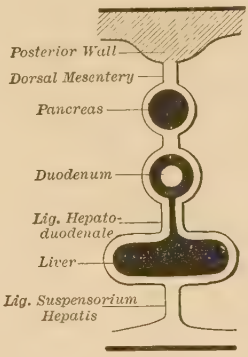


FIG. 100.—Schematic illustration of the intestinal canal in a human embryo of the sixth week. (After TOLDT.)

FIG. 101.—Diagram illustrating the origin of the liver. (After O. HERTWIG.)

sp. Œsophagus. *kc.* Lesser curvature. *gc.* Greater curvature. *du.* Duodenum. d^1. Proton of small intestine. d^2. Proton of large intestine. d^3. Vitelline duct. *mg.* Mesogastrium. *ms.* Mesenterium. *m.* Spleen. *p.* Pancreas. *cl.* Cœliaca. *ao.* Aorta. *mei.* Mesenterica inferior. *ac.* Aorta caudalis. *r.* Rectum.

terminates in a wide dilatation—the *cloaca*—which forms the common receptacle for the excretions from intestines and bladder.

As the intestine elongates and separates from its attachment to the body-wall, the mesoderm is drawn out as a thin membrane, which later becomes the *mesentery*. (Fig. 99.) About the fourth week an invagination of the ectoderm takes place on the ventral side of the embryo opposite to the terminal portion of the cloaca, by which the ectoderm is brought into contact with the entoderm, the two layers giving rise to the *anal plate* (Plate XII., Fig. 7, *a*), and the ultimate rupture of this plate forms a cloacal opening which afterward becomes the *anus*.

The *liver* arises about the fifteenth day as a hollow diverticulum from the ventral side of the fore-gut just below the heart (Fig. 101), and almost immediately gives off a second evagination. (Fig. 102.) The walls of these pouches become greatly thickened, and their distal ends are sur-

rounded by a mass of yolk-cells which become separated off from the rest of the yolk. A network of solid cords is next developed in the cell-mass, and these, acquiring a lumen during the fourth week, form the proton of the *hepatic ducts*. The meshes of the network are filled with bloodvessels. The liver enlarges rapidly, so that at birth its weight in proportion to that of the whole body is twice as great as in the adult. The canal of the original diverticulum becomes the *common bile-duct* (*ductus communis choledochus*), and from this, before the end of the fifth week, a bud is given off to form the *gall-bladder*.

The *pancreas* is developed during the fourth week as a diverticulum from the dorsal side of the duodenum nearly opposite the liver evagination, and grows into the mesogastrium where it gives off branching buds. The duct opening into the intestine at first lies in front of the bile-duct, but subsequently runs parallel to the latter, and the two open into the duodenum by a common orifice. (Fig. 102.)

Fig. 102.

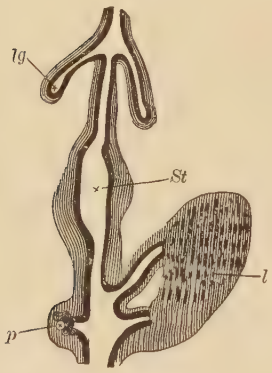


Diagram of liver proton. (After Götte.)

lg. Lung. *St.* Stomach. *l.* Liver. *p.* Pancreas.

During the second week the *pulmonary organs* appear as two diverticula from the ventral side of the œsophagus just above and behind the auricle of the heart. (Figs. 97 and 103.) At this point the œsophageal tube is compressed laterally, and still further caudad becomes pear-shaped, then triangular, and finally separates into three divisions or tubes, the posterior tube forming the œsophagus proper, and the two lateral tubes the *bronchi*. The slit-like aperture through which the pulmonary diverticula open into the œsophagus just behind the fourth branchial arch is the future *glottis*, while the part immediately caudad represents the *trachea*. By the repeated branching of the latter the bronchioles and the alveoli appear.

The *larynx* arises as a widening of the upper portion of the trachea; and the *epiglottis* is developed from a small tubercle situated posteriorly to the tubercle for the tongue.

The lungs project conspicuously into the body-cavity, and, growing dorsad and caudad, push the peritoneum before them in the form of pouches which become the *pleural sacs*. The epithelium lining the pulmonary tract is derived from the entoderm, while the spaces between the bronchioles are filled with bloodvessels and tissue of mesodermal origin.

The Urogenital System. The first indication of the urinary organs appears about the fifteenth day as a pair of rod-like cell masses, probably of ectodermal origin, lying in the tissues, one on either side, between the myotomes and the somato-splanchnopleural junction, and extending from the region of the heart caudad. Each rod acquires a lumen and becomes the *Wolffian duct*. (Plate XII., Figs. 8, 9, *un.*) The caudal ends of the ducts are at first blind, but by rapid lengthening they soon reach to the posterior end of the intestine and open into the *cloaca*. (Fig. 104.) About the eighteenth day a longitudinal ridge appears along the dorsal wall of the body-cavity on either side of the basal attachment of the mesentery. These ridges project into the body-cavity and constitute the *Wolffian bodies*.

Within the ridge on the mesenteric side a series of cord-like thickenings develop and, acquiring a central canal, grow toward the Wolffian duct

FIG. 103.

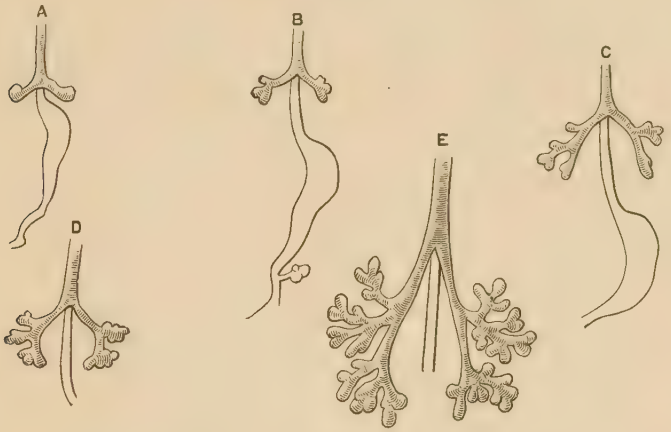


Diagram showing the development of the lungs. (After HIS.)

FIG. 104.

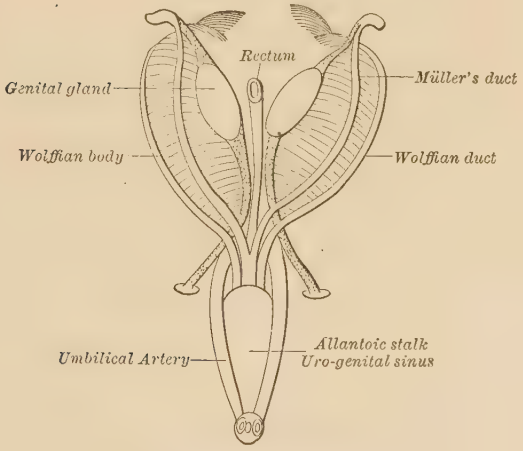


Diagram of urogenital apparatus. (After BONNET).

FIG. 105.

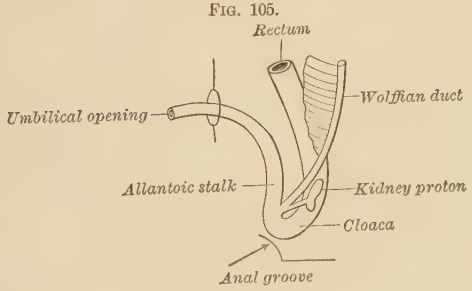


Diagram of kidney proton and cloacal region. (After BONNET.)

into which they open as the *Wolffian tubules*. The distal closed ends of the tubules become dilated and then invaginate to form the *Malpighian bodies;* the *glomeruli* arise from the branches of the aorta which penetrate the Wolffian body at an early period. The veins, as has been mentioned, empty into the cardinal vein. Early in the fourth week an evagination appears on the dorsal side of the Wolffian duct just above the termination of the latter in the cloaca. (Fig. 105.) The distal end of this diverticulum grows rapidly cephalad between the Wolffian body and the vertebræ until it reaches the head-end of the former, where it dilates and covers the Wolffian body dorsally, forming the proton of the *kidney*. The long canal opening into the Wolffian duct represents the future *ureter*, and its upper end, which becomes dilated, the *renal pelvis*. From the dilated part of the renal evagination branches are given off to form the *urinary tubules*, from the blind ends of which the *Malpighian bodies* arise. The kidneys are definitely formed by the end of the eighth week, at which time the resorption of the Wolffian bodies begins, all but the cephalic ends of the latter disappearing. The opening of the ureter is subsequently shifted from the Wolffian duct to the urogenital sinus. (Fig. 106.)

Fig. 106.

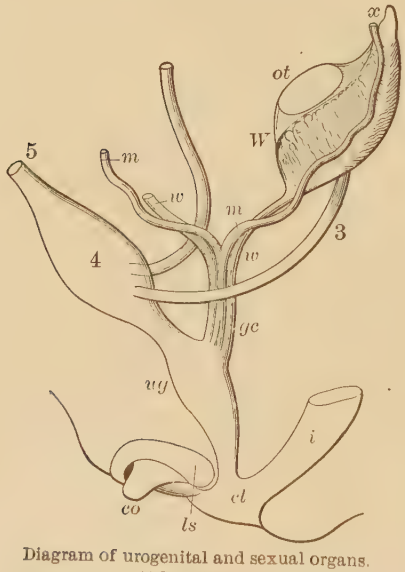


Diagram of urogenital and sexual organs. (After Gray.)

The parts are shown chiefly in profile, but the Müllerian and Wolffian ducts are seen from the front. 3. Ureter. 4. Urinary bladder. 5. Urachus. *ot*. The mass of blastema from which ovary or testicle is afterward formed. *W*. Left Wolffian body. *x*. Part at the apex from which the coni vasculosi are afterward developed. *w, w*. Right and left Wolffian ducts. *m, m*. Right and left Müllerian ducts uniting together and with the Wolffian ducts in *gc*, the genital cord. *ug*. Sinus urogenitalis. *i*. Lower part of the intestine. *cl*. Common opening of the intestine and urogenital sinus. *co*. Elevation which becomes clitoris or penis. *ls*. Ridge from which the labia majora or scrotum are formed.

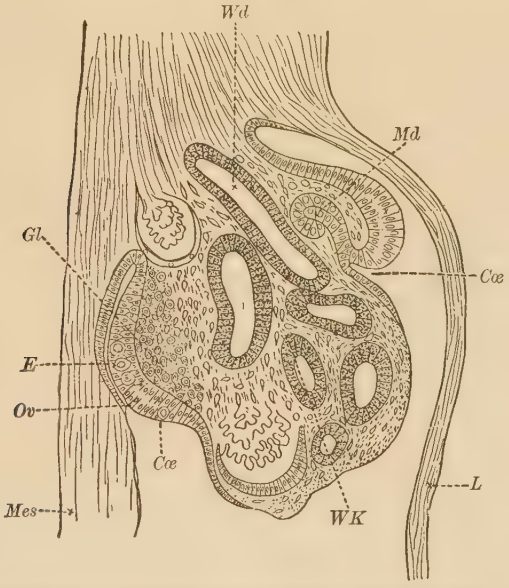
The *suprarenal capsules* are developed partly from the mesoderm and partly from branches arising from spinal sympathetic ganglia. That part of the allantois contained within the abdominal cavity and lying between the cloaca and the umbilicus gives rise during the second month to the urinary *bladder*. The proximal portion of the allantois dilates into a spindle-shaped vesicle, the upper part of which dwindles and finally becomes a cord—the *urachus*. The bladder is lined by entoderm and its walls are formed from the mesoderm. At the close of the fourth week there appears a band of thickened peritoneum (*mesothelium*) along the external lateral border of each Wolffian body, extending caudad to the cloaca. During the fifth week each band acquires a lumen which opens above into the body-cavity and below into the cloaca. These are the *Müllerian ducts*, the prota of the female internal organs of generation.

At an early period there appears on either side along the dorsal wall of

the cœlom between the Wolffian body and the mesentery a small ridge which extends nearly the whole length of the abdominal cavity. (Fig. 107.) This ridge is the *genital fold*, and is formed by the thickening of the peritoneal epithelium, which at this point is called the *germinal epithelium*, because from it are developed the egg-cells of the female and the spermatozoa of the male. The middle portion of the ridge is the proton of the *sexual gland—ovary* or *testis*. At a later stage the caudal ends of the genital ridge draw toward the median line and unite to form the *genital cord*. The differentiation of the sex, which can be determined microscopically as early as the fifth week, depends upon the changes which take place in the sexual gland.

In the *male* the sexual gland becomes the *testis*. A network of epithelial cords is first formed, and embedded in these are the primitive

FIG. 107.



Wolffian body, genital fold, and Müllerian duct of chick embryo, fourth day. (After WALDEYER.)
Wd. Wolffian duct. *Md.* Müller's duct. *E.* Genital epithelium. *Ov.* Primitive ova.
Gl. Glomerulus. *Mes.* Mesentery. *Cœ.* Cœlom.

sperm cells. The cords acquire a lumen and become the prota of the *seminiferous tubules*. They connect with the anterior tubules of the Wolffian body which grow into the testis during the fourth month, and anastomosing in various directions form the *rete testis*. (Fig. 108, *A*.) The outer tubules of the Wolffian body serve as communicating channels with the Wolffian duct—*vasa efferentia*—the duct itself in its upper portion becoming the *epididymis*, and below the *vas deferens*. In the male the middle portion of the Müllerian duct disappears, the upper end in contact with the testis giving rise to the *hydatid of Morgagni;* its lower part buried in the genital cord forms the so-called *uterus masculinus*.

In the *female* the sexual gland becomes the *ovary*. The sexual cords from the genital mesothelium, or, as they are called here, the cords of

Pflüger, contain the primitive ova which become surrounded and separated from one another by smaller cells, forming an epithelial boundary or follicle around each ovum. The tubules from the Wolffian body grow into the ovary in the same manner as into the testis, giving rise to the *parovarium* or *organ of Rosenmüller*. (Fig. 108, *B.*) The anterior portion of the Wolffian duct persists as the longitudinal duct of the parovarium; its caudal end disappears, or remains as the duct of *Gärtner*.

FIG. 108.

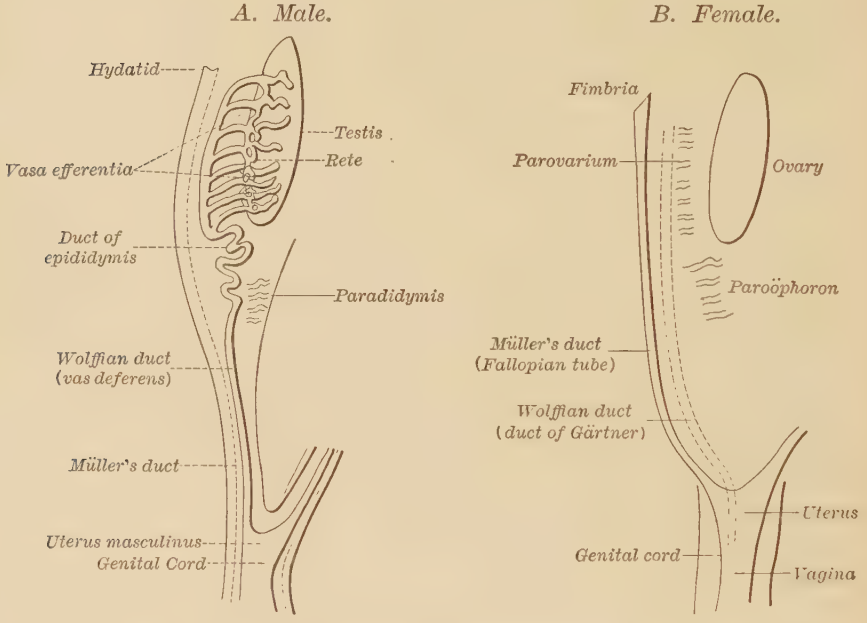


Diagram to illustrate the homologies of the sexual apparatus. (After MINOT.)

The upper portion of the Müllerian duct above the genital cord gives rise to the *Fallopian tubes* or *oviducts*. At first these tubes run parallel with the body, but later they assume an oblique and finally a transverse position in the pelvic cavity, as in the adult. The genital folds as the result of superior growth of the other parts of the fœtus are also carried across the body-cavity, and thinning out give rise to the *ligamenta lata* or *broad ligaments*.

The lower portions of the Müllerian ducts included in the genital cord fuse in their lower middle portions to form a single tube—the *utero-vaginal canal*, the upper part of which is differentiated during the fourth month into the *uterine fundus* and *body*, the *cervix uteri* appearing some time during the fifth month. The lower part of the canal dilates and becomes the *vagina*.

About the fourth week a septum develops and divides the cloaca into two cavities, an anterior, the *urogenital sinus* (Fig. 106), which includes the openings of the allantois and the Müllerian ducts, and a posterior, anal opening. The further growth of this dividing wall carries the two openings more and more apart, and ultimately appears as the *perineum*.

The External Genitals. The development of the external genitalia is the same in both sexes up to the ninth or tenth week. About the fifth week a small projection—the *genital tubercle*—is formed by the thickening of the anterior portion of the anal plate. This is the proton of the

Fig. 109.

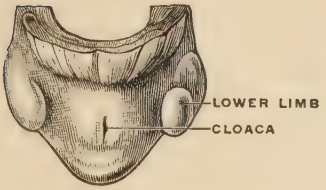


Fig. 112.

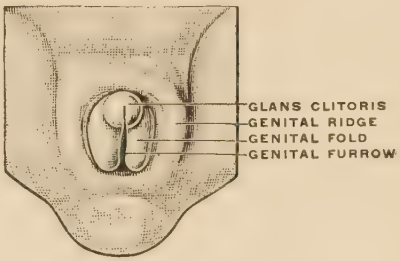


Fig. 110.

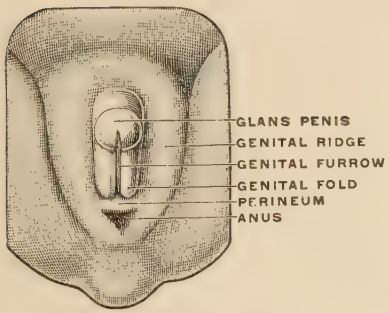


Fig. 113.

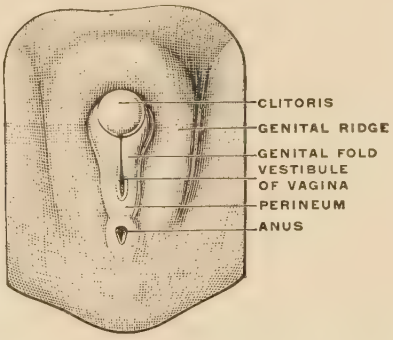


Fig. 111.

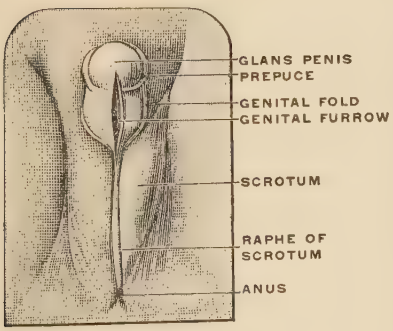
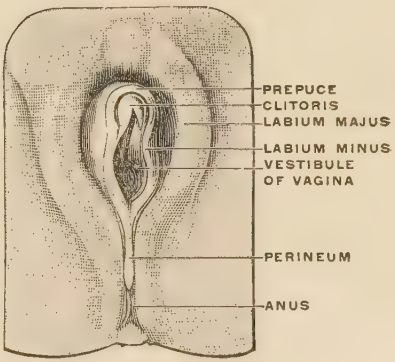


Fig. 114.



Six stages in the development of the external genitals. (After Ecker-Ziegler models.)

clitoro-penis. The tubercle later develops a head or glans, and a furrow —the *genital groove*—appears along its ventral side, running backward to the urogenital sinus. During the tenth week a slight elevation—the *genital labium*—arises on either side of the genital tubercle and extends

backward along the lateral margin of the urogenital sinus. Changes now take place which differentiate the male from the female organs.

In the *male* the genital tubercle elongates and becomes the *penis* (Figs. 109 to 111); and the furrow along its under surface is converted into a canal—the *urethra*—by the growth, apposition, and fusion of the sides of the groove. Their line of union is represented in the adult by the *raphe penis*. Toward the close of the fifth month the *prepuce* is developed as a fold of skin around the base of the glans. The *scrotum* arises during the fourth month by the meeting and fusion of the genital labia, which enlarge and grow downward between the root of the penis and the anus.

In the *female* the genital eminence remains small and becomes the *clitoris*. (Figs. 112 to 114.) The genital groove is closed in to form the *urethra*, while its side folds develop to form the *labia minora* or *nymphæ*. The genital labia give rise to the *labia majora*, the anterior extremities of which become the *mons veneris* or *mons pubis*.

The Skeleton. The osseous system of the embryo is relatively late in appearing, the bones arising either from a preceding cartilaginous stage or independently in membrane. The notochord, the earliest indication of the axial skeleton, is first surrounded by a membranous sheath, outside of which a cartilaginous tube is subsequently formed, and from this arise the bodies and processes of the vertebræ. Ossification takes place in each vertebra from three centres, one for each arch and one for the body, to which two more centres are added later for the epiphyses.

Fig. 115.

Development of the human anterior extremities. (Allen Thomson, after His.) *A*. At four weeks. *B*. At five weeks. *C*. At seven weeks. *D*. At nine or ten weeks.

The *pelvis* appears as a bar of cartilage (*ilium*) on either side, articulating at the middle with the femur, and united at their ventral ends by connective tissue. The *ischium* and *pubis* arise ventrally from the acetabular region and uniting at the symphysis enclose a space, the *obturator foramen*. By the end of the third month ossification begins from three centres, one for each bone, but the union of the three to form the innominate bone is not completed until puberty.

The extremities (Fig. 115) arise during the third week as bud-like outgrowths from a lateral longitudinal ridge extending along the ventral ends of the muscle plates for nearly the whole length of the embryonic trunk.

EMBRYO AND FŒTUS AT DIFFERENT PERIODS OF DEVELOPMENT.[1]

First month—visceral arches and clefts readily distinguished. Spinal canal closes. Buds of rudimentary extremities appear. Indication of

Fig. 116. Fig. 117. Fig. 118. Fig. 119.

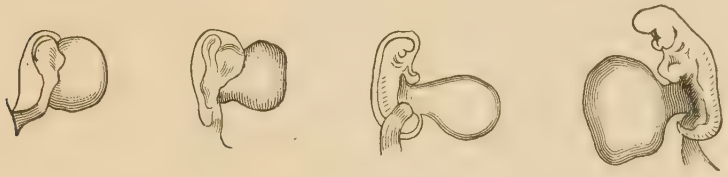
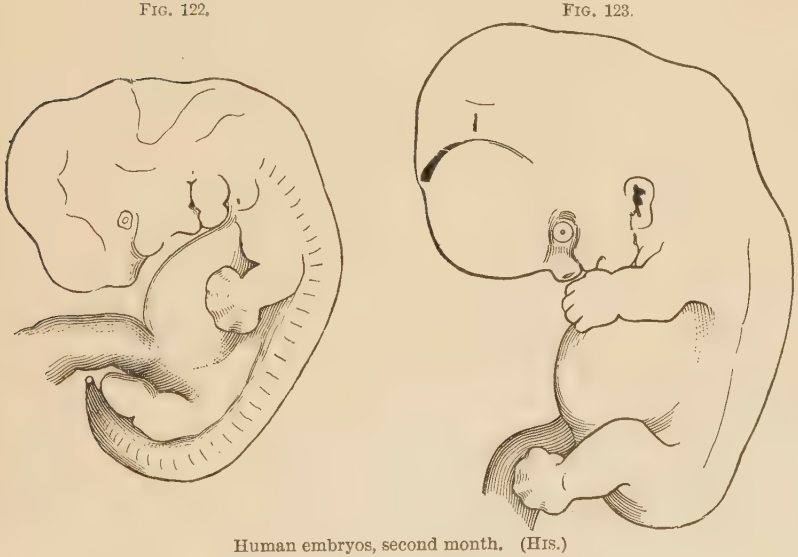


Fig. 120. Fig. 121.

Human embryos, first month. × 5. (His.)

Fig. 122. Fig. 123.



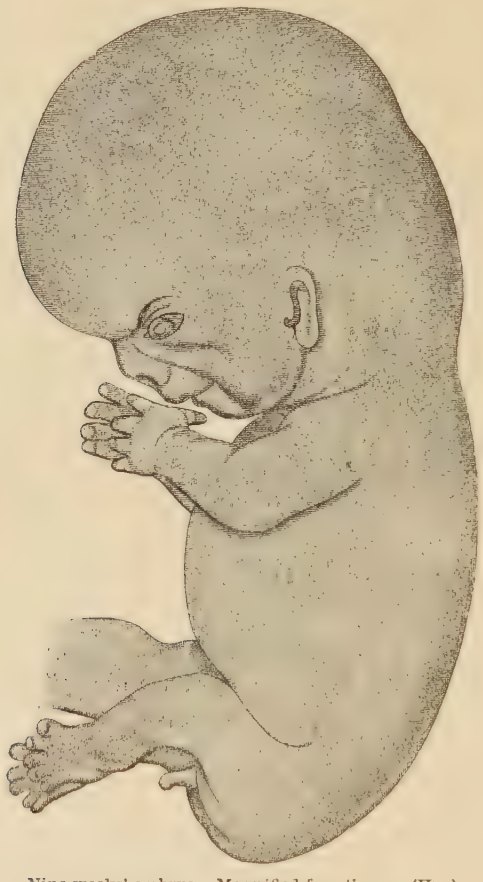
Human embryos, second month. (His.)

[1] On account of the great variance of tabulated observations and difference in the development of individual embryos of the same age, uniformity and accuracy in weights and lengths are impossible. After the second month the weights and lengths given above in grammes and centimetres are taken from Hecker's well-known tables. The weights and lengths in grains and inches are from various English and American sources. They must be considered as only approximate.

eyes, anus, mouth. The heart is four-tenths of an inch long. (Figs. 116 to 121.)

Second month—about 2.5 cm., 1 inch long. The eyes, nose and ears are distinguishable. Suggestion of hands and feet. External genitals. (Figs. 121, 122.)

Fig. 124.



Nine weeks' embryo. Magnified four times. (His.)

Third month—products of conception about the size of a goose-egg. Fingers and toes separated. Nails as fine membranes. Neck separates head from body. Sex distinguishable; uterus formed. Length, 4 to 9 cm., 5 inches; weight, 5 to 20, average 11 grammes, 460 grains. (Fig. 124.)

Fourth month—10 to 17 cm., 6 inches, long; weight, 10 to 120, average 57 grammes, 850 grains. Short hairs, lanugo, present. Head equal to about one-fourth of entire body.

Fifth month—18 to 27 cm., 10 inches, long; weight, 75 to 500, average 284 grammes, 8 ounces. *Vernix caseosa* forming. Eyelids begin to separate. Heart-sounds perceptible. Quickening takes place.

Sixth month—28 to 34 cm., 12 inches, long; weight, 375 to 1280, average 634 grammes, 23½ ounces. Hair on head. Eyebrows and lashes. Testicles near rings.

Seventh month—35 to 38 cm., 15 inches, long; weight, 780 to 2250, average 1218 grammes, 41½ ounces. Pupillary membrane disappears.

Eighth month—39 to 41 cm., 16 inches, long; weight, 1093 to 2438, average 1569 grammes, 3½ pounds. Left testicle descended. Nails do not protrude beyond finger tips. Lanugo begins to disappear.

Ninth month—42 to 44 cm., 18 inches, long; weight, 1500 to 2906, average 1971 grammes, 4½ to 7 pounds.

Tenth month—Lanugo almost entirely disappeared. Skin pink; flexor surfaces covered with vernix; both testicles descended in males; labia majora in apposition in females; intestine contains abundance of meconium; eyes open. Length about 50 cm., 20 inches.

CHAPTER III.

CHANGES IN THE MATERNAL ORGANISM CAUSED BY PREGNANCY.

These changes are, naturally, most marked in the generative organs, and consist in a congestion and hypertrophy of all their structural elements. A moderate hyperplasia, undoubtedly, also occurs in the early months.

The Uterus. The normal site of implantation, presents changes in its size, form, position and structure that are more extensive than occur under any other physiological condition.

Size. From a small pelvic organ in the unimpregnated state, weighing about 50 grams, $1\frac{1}{2}$ ounce, it progressively enlarges until at the end of pregnancy it occupies a large part of the abdominal cavity and weighs about 1 kilogram, $2\frac{1}{2}$ pounds. It has thus increased in size about 25 times. The enlargement in the early months is mainly due to the specific impulse of pregnancy, as a similar increase in size occurs in cases of extra-uterine implantation. In the later months, however, the growth of its contents is the chief factor in the enlargement. The increase in size cannot ordinarily be appreciated until the latter part of the second month, partly because of the softening that begins simultaneously with its growth. The fundus can be felt above the pelvic brim after the third month and it reaches in the succeeding months to fairly uniform positions on the abdominal wall, which are of greater or less value in estimating the duration of pregnancy. Variations in its size are common, particularly in the last three months, due to differences in the size and amount of its contents.

Form. The pyriform shape of the unimpregnated uterus is first succeeded by a more or less asymmetrical form, due to the greater hypertrophy that primarily occurs at the part nearest the site of implantation, which is most often in the neighborhood of one of the uterine horns.

The remainder of the body soon shares more equally in growth so that in the middle of pregnancy the shape resembles an inverted jug. As the hypertrophy of the fundus exceeds that of the lower zone a more or less ovoid shape is seen in the later months. As a result, the insertion of the tubes and round ligaments is situated at a relatively lower level than in the unimpregnated organ. The growth is also somewhat greater over the placental site so that the round ligaments occupy a position more anterior or posterior according as the placenta is situated in the posterior or anterior wall. (Fig. 126.) Olshausen, however, from observation of a large number of cases does not consider their position to be a reliable guide for the location of the placental site in performing the operation of Cæsarean section. The form like the size, especially in multiparæ, varies in the later months with the size and position of the contents.

The Position of the uterus is fairly constant at different periods of pregnancy. On account of the softening and increased weight, the normal anteversion and anteflexion is first slightly exaggerated. If the uterus immediately prior to pregnancy has been in a position of retroversion or retroflexion, these positions also are primarily more pronounced. As the enlargement progresses, and successively higher positions in the abdominal cavity are obtained, the anteflexion becomes less marked, although a rather uniform and close relation to the abdominal wall is maintained throughout the pregnancy, varying somewhat with the posture of the woman and the muscular tone of the uterine and abdominal wall.

FIG. 125.

Most frequent form of full term uterus.
(E. BUMM.)

FIG. 126.

Pregnant uterus of the third month.
(E. BUMM.)

Coincident with its appearance as an abdominal organ a slight dextroversion with right torsion occurs in 80 per cent. of cases. (Pfannkuch.) In addition to such causes as, the general custom of lying upon the right side, the lessened amount of space in the median line from the projection forward of the vertebral column, and the position of the sigmoid, it is probable that causes reverting to developmental peculiarities may be operative. Bodon's case of transposed viscera, in which a sinistro-version of the uterus existed, is suggestive in this connection. After the uterus has finally reached its highest position in the abdominal cavity about two weeks before labor begins, it quite regularly assumes a lower level in primiparæ if the relations between the fetal head and pelvis are normal. In multiparæ, however, because of the lessened tone of

both the uterine and abdominal wall, this phenomenon occurs infrequently.

The Structure of all the uterine elements is known to be modified by pregnancy, although certain histological details are as yet not definitely determined.

The mucosa first shows these changes, and in a most marked degree at the site of implantation. It becomes swollen coincidently with conception and is thrown into numerous folds. A marked congestion, analogous to that which occurs with normal menstruation, instead of being followed by the retrograde changes incident to that process, becomes the leading factor in a process of hypertrophy and hyperplasia of all the cellular elements. The most characteristic of these changes is the transformation of the small and indifferently-shaped cells into cells, most of which are of an oval or polygonal form, five or ten times larger, resembling epithelium, and called decidua cells. They form practically the entire bulk of the inner portion of the mucosa, and constitute what is known as the compact layer. The glands also primarily become more numerous and larger and, being pushed toward the musculature, form the outer or spongy layer. The two layers, together known as the decidua, are always formed whether the implantation occurs within or without the uterus. The decidua becomes thickest in the third or fourth month. Its character varies in different parts of the uterus. The portion immediately beneath the site of implantation, called the decidua basalis, shows the greatest amount of reaction and is characterized by the development of large vascular channels, which are best described in connection with the development of the placenta. The remainder of the mucosa, designated as the decidua vera, shows a slightly less active change in the lower uterine zone, and regularly ceases at the level of the internal os, except for the occasional appearance of isolated patches of decidual cells immediately beneath the epithelial lining of the upper part of the cervical canal. Patches of these cells are also occasionally seen in the muscular layer without having any pathological significance. A layer surrounding the ovum, called the decidua capsularis, has a similar structure except that the changes are less marked, the glands especially being less developed. Its existence, too, is more transitory, the entire layer practically disappearing in the third or fourth month by uniting with the decidua vera, which at this time also begins to thin out, both from the pressure of the growing fetus and from an actual degeneration, so that at the termination of pregnancy its structural elements are recognizable. Shick has recently demonstrated the presence of lymph spaces in the decidua, especially in the spongy layer near the junction with the compact portion where the natural plane of cleavage occurs in labor.

Fig. 127.

a. Muscle cell of non-gravid uterus. *b*. Muscle cell of a full term uterus. (E. Bumm.)

The muscle cells contribute in largest measures to the extraordinary development of the organ. Besides a moderate formation of new cells

in the early months, there is an extensive hypertrophy by which the pre-existing cells become about ten times longer and about five times wider than in the unimpregnated state. (Fig. 127.) The uterine wall thus becomes thicker in the early months but after the fifth month it is slightly thinner from the growth of its contents.

Arrangement of the Muscle Cells. It is improbable that pregnancy materially alters the arrangement which exists in the non-pregnant organ, except that a division into separate layers may more easily be recognized because of the enormous increase in size of both the muscle cells and the blood-vessels.

A very intimate relationship exists between the latter and the muscle cells. The view of Roesger that there are no definite layers is undoubtedlyincorrect, the muscle cells simply appearing and developing incident

FIG. 128.

Shows the connection between the circular fibres of the tube and the primitive musculature of the uterus. (WERTH and GRUESDEW.)

to the growth of the blood vessels, thus determining their arrangement. Three layers are recognizable, the general arrangement of which may best be understood from the recent work of Werth and Gruesdew upon the fetal development of the uterine muscle. According to these authors, there first appears in the fifth month of fetal life a muscular layer which is a continuation of the circular layer of the Fallopian tubes, representing the primitive layer, called by them the *Archimyometrium*. The bundles of this layer, running apparently in different directions according to the cut section in which they are observed, are strengthened by commisural

fibres that join the two sides. A second layer soon develops external to the primitive layer in the connective tissue immediately beneath the peritoneum, and designated *Paramyometrium.* (Figs. 128 and 129.)

Coincident with the development of the blood-vessels a third or middle layer appears, in which the muscle-cells intimately follow the varied course of the blood-vessels and, intertwining more or less with the other layers, make the division into separate layers less distinct. The physiological importance of this close relationship is first shown at puberty by the marked growth of this layer consequent upon the greater development of the vessels, by means of which the proper vascular control of the adult organ is maintained. The still greater hypertrophy of this layer in pregnancy, following the enormous development of the vessels, demonstrates

FIG.. 129.

Frontal section through body of uterus, showing the meeting of the fibres of the archimyometricus from the two bones. (WERTH and GRUESDEW.)

its importance in controlling the vascular supply at the completion of the third stage of labor. The external and internal layers are most developed in the upper zone, thus supplying the power for the expulsion of the uterine contents during labor. A more detailed description of the direction of the muscle bundles in the separate layers may be obtained by consulting the works of Helie, Luschka, Hoffman and C. Ruge.

Elastic Tissue. Although the muscular development in the lower zone is less marked than at the fundus, it is most probable from the work of Woltke and L. Pick, that a preparation for the dilation of this zone is made by a growth of elastic tissue in the later months.

Blood-vessels, Lymphatics, Nerves and Connective Tissues. All of these structures share in the hypertrophy, but the blood-vessels present the most marked changes, the veins especially becoming of enormous size.

Olshausen relies upon the greater development of the sub-peritoneal veins over the placental site as an accurate guide to its location in performing the operation of Cæsarean section. A recent study of Keiffer shows that between the smallest arteries and veins large spaces exist

Fig. 130.

Injected arteries and veins of a pregnant uterus, from a corrosion preparation by Hyrtyl.

which become filled with blood during uterine contraction, thus making the uterus somewhat of an erectile organ.

The Peritoneum is thicker during pregnancy and has a looser attachment to the muscular layer so that even at the fundus it slides easily over the underlying muscle. This is readily demonstrated by the ease with which this layer is separately sutured in the Cæsarean operation. Isolated groups of decidual cells are occasionally seen beneath this layer under physiological conditions.

The Cervix, although not sharing with the body in its enormous, growth, increases slightly in size because of added vascularity and edema. As a result its consistence is very soft, beginning in the tissues at the external os just beneath the mucosa and extending upward to the internal os. A slight increase in length during the early months is main-

tained until the end of pregnancy, although to the examining finger a shortening is very apparent during the ten days prior to the onset of labor. The marked softening of the vaginal attachment, and the projection downward of the anterior vaginal wall from the sinking of the presenting part of the fetus, partially accounts for this discrepancy between the clinical appearance and the actual conditions as determined anatomically by numerous observers. The shortening, however, actually occurs and in primiparæ especially, affords a valuable sign of the near approach of labor. A most satisfactory explanation of these differences of opinion is that preliminary uterine contractions accomplish the shortening, before the patient has any subjective appreciation of their presence.

FIG. 131.

Frontal section of cervix and portion of vagina. Shows the reduplication of the outer longitudinal fibres running from cervix to vagina. Also the cut (*a*) ends of inner circular fibres. (WERTH and GRUESDEW.)

The cervical mucosa undergoes no regular transformation into decidua, but it becomes swollen and the secretion of the glands is increased, furnishing a thick mucus that fills the canal and forms what is known as the "mucus plug." The musculature of the cervix, although but slightly hypertrophied, is probably formed chiefly from the primitive layer, which is well developed as a circular band at the level of the internal os, and as an external longitudinal layer which is continuous with the muscular layer of the vagina (Fig. 131). The vaginal portion of the cervix, being formed, according to Werth and Gruesdew, by a reduplication of this longitudinal layer, thus disappears in labor through an unfolding by reason of the uterine and vaginal contractions.

The Uterine Adnexna, including the broad ligaments, tubes and ovaries, are affected by the added vascularity and the changes in the size and position of the uterus.

The broad ligaments become unfolded and the blood-vessels, especially the veins, reach an enormous size. The round ligaments also quadruple their size and often may be felt through the abdominal wall.

The tubes increase slightly in length and all of their layers are moderately swollen. Isolated islands of decidual cells have occasionally been noted in the mucus layer.

The ovaries are also somewhat enlarged from the hyperemia, and cells resembling decidual cells have been observed in their stroma. The ovaries and tubes assume a closer relation to the uterus and hang down vertically by its side on account of the unfolding of the broad ligaments.

The Vagina shows the effects of congestion to a marked degree by a softening and bluish discoloration, especially in the lower part of the anterior wall, which often protrudes through the vulvar orifice very much as it does in certain pathological conditions. The length of the walls is slightly increased; the normal papillæ of the mucosa are hypertrophied, imparting to the examining finger a granular feeling. The secretion is also increased. The muscular layers are regularly hypertrophied in preparation for their share of the work in labor, which as shown by the recent experiments of Kurdinowsky upon animals, evidently have a more active part in the expulsion of the gestation products than is generally thought. It is likely that the nerves, also, are hypertrophied since the vagina is more sensitive in pregnancy. The veins occasionally become so dilated in the vaginal walls as to be a source of danger from rupture during labor.

The External Genitals undergo similar changes. The labia are swollen and varicosities appear, especially in multiparæ, which may be both uncomfortable and dangerous. As a result of the softening of the neighboring structures the pelvic floor is relaxed and projects downward.

The Pelvis Articulations are softened by the hyperemia of the interarticular cartilages, particularly the symphysis pubis, in which a limited degree of motion is present toward the end of pregnancy. The other joints are less affected, but the sacro-coccygeal in the early part of the child-bearing period is softened sufficiently to permit of considerable recession of the coccyx during the expulsion of the child. While these changes may contribute very little to the actual enlargement of the pelvis, it is probable that they are of some aid in the parturient act.

General Changes. The changes induced by normal pregnancy in the maternal organism at large are the result of pressure from the increased size of the uterus, of circulatory disturbances consequent upon the modified blood supply of the generative organs, and of certain metabolic changes incident to the pregnancy itself.

Pressure and Circulatory Disturbances are most frequently combined.

The Bladder, from its proximity to the uterus, and because of their intimate vascular relations, is invariably affected. In the early months from the hyperemia and from the pressure of the growing uterus before it has risen out of the pelvis, an increased frequency of micturition occurs. The same conditions prevail near the end of pregnancy, especially in primiparæ, from the pressure of the fetal head as it becomes engaged in the pelvic brim. The bladder also rises with the uterus and becomes more of an abdominal organ.

The Stomach and Intestines are markedly displaced backward and upward, although the functional disturbance of these organs is comparatively slight. The function of the stomach may be slightly disturbed from metabolic changes in the early months, but the appetite and digestion are usually improved in the later months. A constipation that has existed before pregnancy may be improved, or it may be worse, or constipation may first appear in pregnancy. Anatomical studies of Füth

show that from the fourth month the cæcum is displaced upward and toward the median line so that in the later months the appendix occupies a position behind the uterus and in a more dangerous surgical position.

The Kidneys are little, if at all, changed. The very general opinion that a slight congestion from pressure, and circulatory change, forms the anatomical basis of the frequent appearance of a slight albuminuria in an otherwise normal pregnancy, constituting what is known as the pregnancy kidney, is based upon evidence insufficient to justify the assumption that any amount of albuminuria is physiological.

The Ureters are normally displaced and pressed upon by the pregnant uterus so that one or both are often dilated, the right one more frequently because of the frequent presence of the dextro-version of the uterus.

The Liver and Spleen are said by many writers to be constantly enlarged. Evidence of the truth of this statement is insufficient, and it must be confessed that exact knowledge of the normal condition of either of these organs in pregnancy is uncertain. There is some evidence that the liver in pregnant animals is more fatty. It is fair to assume that some histological differences exists in organs, upon which two organisms, instead of one, are so dependent for important metabolic changes.

The Abdominal Wall varies in size and shape with the size and position of the uterus, being more pendulous in multiparæ and in women with contracted pelves. As a result of its overdistention, the superficial layers of the skin becomes so thin that the more vascular layer beneath is more readily seen, and lines of a pinkish color, called striæ, appear. They are subsequently observed as white scars, which in a later pregnancy may be seen in conjunction with the pink ones of that pregnancy. These striæ, although more marked and more numerous in utero-gestation, may occur with large abdominal tumors or in women who have rapidly grown obese.

The Heart and Lungs are somewhat displaced in the later months from the pushing upwards of the diaphragm, but a compensatory widening of the chest ordinarily prevents undue interference with their function. A moderate embarrassment is occasionally seen, especially in short women and in pregnancies in which either the fetus is large or the amount of liquor is excessive. The heart is displaced towards the left and against the chest wall, thus giving the physical signs of enlargement, which was formerly thought always to occur. The actual existence of a normal hypertrophy is still a matter of doubt. A very recent study by Tuszki would lead us to believe that a hypertrophy does regularly occur. Murmurs, thought by many observers to be due to the displacement, are now recognized as the result of a concomitant anemia.

THE NORMAL METABOLISM OF PREGNANCY.

All of the other changes in the maternal organism may best be considered as expressions of some metabolic disturbance, arising from the demands of a growing fetus. Our present knowledge of metabolism in pregnancy is scanty, but it is natural to assume that a greater vitality and a greater capacity to assimilate is necessary, the truth of which is partially expressed by certain clinical phenomena.

The Body Weight, chiefly from the work of Gassmann and Baum, is known to be increased in the last three months beyond a point that can

be accounted for by the increased size of the fetus and pelvic organs. According to Gassner this increase is directly proportional to the size of the woman and is greater in multiparæ.

The intake of oxygen and the excretion of carbonic dioxid, undoubtedly are increased.

The Skin furnishes numerous evidences of metabolic change. The hair follicles, the sebaceous and sweat glands are more active. A constant expression of such change is the pigmentation of the median line of the abdomen from the symphysis pubis to the umbilicus, most marked in brunettes, and often extending to the ensiform cartilage, broken only by a pigmented ring surrounding the umbilicus. Such pigmentation is frequently seen, also, in other regions of the body, as about the forehead and cheeks where it is known as the cloasma uterinum. Such manifestations have received various explanations, as follows: parasitic; changes in the blood, particularly an anemia associated with heart hypertrophy and hypoplasia of the vascular system; amenorrhœa; a depost of iron from a cystotoxin. Similar changes are seen in young girls suffering from amenorrhœa and dysmenorrhœa, and, like many other skin manifestations such as, herpes, pityriasis, fibroma molluscum gravidarum (Brickner), are undoubtedly of metabolic origin.

The Thyroid Gland, by its frequent enlargement in pregnancy and its return to normal size immediately after labor, furnishes important evidence that pregnancy is normally associated with some characteristic matabolic change. According to Lange, it was found enlarged in 166 out of 267 cases, and more frequently in primiparæ. Its increase in size began in the largest number of cases in the fifth and sixth months, oftener in the sixth month in primiparæ. He says the enlargement is the result of both hypertrophy and hyperplasia, due to substances circulating in the blood, either metabolic products that are peculiar to pregnancy, or such as are formed in greater quantity than in other persons. As to its significance, Lange found from 133 observations made in the last 12 weeks of pregnancy, that out of 22 cases with no enlargement and of three in which the size was doubtful, 18 showed positive signs of kidney disturbance; while of the remainder with enlargement, only two showed kidney changes. The gland was found regularly enlarged in pregnant cats. Complete extirpation in both pregnant and non-pregnant animals was regularly followed by tetany. Extirpation of four-fifths of the gland in non-pregnant cats was followed by no ill effects, while removal of the same amount of gland tissue in pregnant animals, if they lived six days, was followed by convulsions and coma with marked kidney changes.

The Urine has naturally been the chief point of interest in the study of the metabolism of pregnancy. Observations, however, have been limited mostly to pathological states, and the number of examinations, fulfilling all the requirements for the proper study of metabolism, have been so few that our present knowledge largely consists in a better appreciation of the faulty conclusions which have been derived from the ordinary clinical methods of the past. A few facts are definitely determined. The conclusions of Winckel that the amount of urine excreted during the latter half of pregnancy is increased, from 200 to 300 c.c. in 24 hours, have received general recognition. The increased frequency of micturition is undoubtedly partly due to this polyuria. The specific gravity in the later

months is usually slightly lower, averaging a little less than 1015. The amount of the urinary solids excreted during pregnancy, compared with the non-pregnant state, is not definitely known. Unfortunately, there is no method at the present time that is easily available to the clinician for the determination of the amount of the nitrogen-containing compounds. The ordinary hypobromite method for the estimation of the urea has recently been shown by Ewing and others to be misleading, because the amount of nitrogen excreted as urea normally varies so much with the diet and because some of the other nitrogen compounds are included in the test. Experimental work upon pregnant animals and women by Hägeman, Zacharjewsky, Schräder, Ver Ecke, Jägeroos, and Hahl, show that in the latter part of pregnancy there is a moderate retention of nitrogen. The extra nitrogen may or may not be used for the nutrition of the growing fetus. Jägeroos by experiments on dogs carried out throughout the entire period of pregnancy found that this retention is preceded in the early months by a loss of the nitrogen balance.

It is possible that this slight disturbance in the nitrogen balance may be the basic expression of an autotoxic state normally incident to pregnancy. All of the other urinary constituents are so far not known to differ in their relative amounts from the non-pregnant condition, nor are there any new substances known to be regularly present, under physiological conditions, except a few blood cells in the last few days from the extra congestion of the bladder mucosa.

The Blood. Recent study has shown that the blood in normal pregnancy differs little from that of the non-pregnant state. Changes that were formerly thought to exist are now known to have been due, either to imperfect technique, or to the selection of abnormal cases for the examinations. Payer's conclusions, based upon an extensive review of the literature and his own personal observations, give the best summary of the present knowledge of the subject. According to this author, the specific gravity and the alkalinity are probably lowered. The amount of hemoglobin and the number of red cells are not changed, although the size and shape are more varied, showing degenerative and regenerative changes. The white cells, as recognized by practically all observers, are constantly increased in number, especially in the last few weeks, corresponding to what is generally known as the upper limit of the physiological number. The cause of this leucocytosis, first ascribed by Virchow to the enlargement of the pelvic lymphatics and subsequently by Johnstone and others to absorption from the lymphoid structure of the endometrium, is apparently related, as is the decreased alkalinity, to the increased metabolic activity resulting from the enormous hypertrophy of the genital organs and the demands of the growing fetus. The fibrin-forming ferment is said by the majority of authorities to be increased.

The Bones and Teeth. The most common change noted in the bones is the appearance of the so-called osteophytes, which are seen most frequently upon the inner surface of the cranium in the region of the middle meningeal artery. They are also seen, although less frequently, in other regions, and may be found in other conditions than pregnancy. Their appearance has not been satisfactorily explained but in the light of our present knowledge they are probably of metabolic origin. Hanau has studied them in relation to osteomalacia, by which it appears as if they

might be regarded in some respects as a physiological precurser of that condition. It is said that fractures of bones during pregnancy unite less readily but it is doubtful if this is true. The teeth are proverbially mentioned as undergoing changes during pregnancy. There is no doubt that caries frequently occurs. There is no evidence, however, to show that teeth previously normal are specifically affected by pregnancy. They afford rather an excellent example of the deleterious effect of pregnancy upon organs previously diseased.

The Nervous System. The majority of the symptoms occurring in pregnancy have been ascribed at some time or other to changes of the nervous system. Recent study, however, has failed to show that normal pregnancy produces any characteristic changes. The experimental work of Blumreich and Zuntz has shown that the motor area of the cortex in pregnant animals is more responsive to certain artificial stimuli than is that of non-pregnant ones. It is more probable that most of the symptoms classified as due to minor nervous disturbances are essentially expressions of some, perhaps serious, pathological disturbance of metabolism.

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CHAPTER IV.

DIAGNOSIS OF PREGNANCY.

Method, clearness, and perspective are not more necessary to the student in learning the signs of pregnancy than is the acquisition of a habit of orderly procedure to the practitioner in making a diagnosis of this condition. The difficult cases are many; the result of error is ridicule. Vander Veer has collected sixty-eight instances of operation on supposed pathological growths, some of the operators being men of note. The laity imagine that it cannot be hard to tell whether or not there is a child in the womb, and often insist upon a positive conclusion. This demand is strongest in the early weeks when the signs are fewest and faintest. A relatively large amount of space has, therefore, been accorded to the changes in the second and third months, and to their literature, whereas the later major signs are our common property, whose history may be omitted in this short chapter.

In addition to the main question—whether certain indications are or are not present—the examination will necessarily touch on the possibility of the diseases that simulate each sign; the estimate of the period to which gestation has advanced, in order to collate all the signs due at that period, and the queries whether the pregnancy is normal or abnormal, the child alive or dead. Many other facts, very nearly connected with the subject-matter of this chapter, but more commonly inquired into a month before labor, are relegated to the antepartum examination, which may be found under the chapter on the Management of Labor. In quizzing, one asks concerning each sign: what its character is, its cause, the method by which it is brought out, its location, the date of appearance and duration, and what conditions other than pregnancy may counterfeit or develop it. Only through bedside instruction can the student learn the look of the areola or acquire skill in palpation and auscultation.

The *four steps of the examination* follow an obvious order: History from the patient; physical exploration, mammary, abdominal, pelvic.

I. History.

The chief symptoms obtainable from the patient are cessation of menstruation, nausea, enlargement of the breasts and abdomen, and quickening.

Suppression of Menses. After conception menstruation ceases. This is usually the first sign to draw attention to the condition. "In a woman of previously regular menstrual habit, and in the absence of other appreciable causes of amenorrhœa, the arrest of the catamenia is to be regarded as strong presumptive evidence of pregnancy."[1] The importance of this evidence increases after the second omission, since belated appear-

[1] Essentials of Obstetrics, by Charles Jewett. Lea Bros. & Co., Phila., 1897. From this book the writer's classification is mainly drawn, with much more besides.

ance of the flow for a few days to two weeks is not uncommon. It is most weighty, as indeed may be said of all the signs, when it corresponds in time with the size of the uterus and the usual date of appearance of the other evidences of pregnancy.

Three things lessen the value of this sign :

a. There are other causes of amenorrhœa. These are mainly anæmia, tuberculosis, chilling, delay in menstruation, emotional causes, nephritis, as well as change of climate, obesity, the menopause, pelvic inflammations and tumors, and an irregular menstrual habit. Newly married women or those fearful of the results of wrong-doing are rather prone to run over their time ; the sea voyage checks the flow with our immigrants ; or the climacteric may arrive early.

b. An apparent menstruation may take place in early pregnancy. This is infrequent, so that a woman who is unwell regularly, however scantily, is almost always wrong in her suspicion of pregnancy. When a periodic flow does occur during gestation—and a woman calls any more or less periodic flow her courses—careful questioning will elicit evidence of lessened quantity, a thin or serous character, or some variation in typical increase and tapering off. Such flow rarely takes place after the third month, when the decidua reflexa and vera have no longer a cavity between them. The source lies usually in some lesion of the cervix, in an endometritis or polyp, or even in a placenta that is prævia. A patient illegitimately pregnant not infrequently denies amenorrhœa, or places the last period later than the true time. The denial may be volunteered in the hope that during local treatment a sound will be passed. A few cases have been reported wherein menstruation apparently continued throughout pregnancy, or took place then only.

c. Pregnancy sometimes begins in patients not menstruating. Conception may occur before the function is established, as is *de rigueur* among certain of our Indian tribes; or after the function has ceased; or it may take place during the physiological amenorrhœa of lactation; or, lastly, in those who are in the habit of skipping periods. It should be said also that impregnation happening just before a period may affect it little.

Nausea and Vomiting. This is a frequent accompaniment of early pregnancy, ranging from an occasional qualm to inability to retain any food. It is a reflex from the stretching of the uterine muscle-fibres and nerves or from pressure in the pelvis. Occurring late in pregnancy, pressure and displacement explain it. The grades or degrees may be placed in the following clinical groups : (*a*) Nausea absent or slight in a considerable percentage of cases ; (*b*) nausea with occasional vomiting during the second and third calendar months (fourth to thirteenth weeks)—a very common condition ; (*c*) long-continued, distressing, debilitating, but not dangerous, retching and vomiting ; (*d*) vomiting imperilling the health, and (*e*) threatening life. The disorder is generally a morning sickness on first rising, or may be only after meals, or solely when the stomach is empty. Infrequently it begins soon after conception, and may last throughout gestation.

Its value as a witness to pregnancy is scant, since it occurs in gastric catarrh, chronic nephritis, and as a reflex in pelvic disorders and many others. If it has always appeared at a given time in previous pregnancies, it has some weight.

Salivation many times accompanies the sickness. The secretion is tenacious and difficult of expectoration, hence the name "spitting cotton." Heartburn, abnormal appetites, longing or loathing toward various strange articles of food, toothaches, and the like, may be present.

Enlargement of the breasts, with throbbing, tingling, stretching fulness, or secretion, may be complained of, with tenderness of the nipples, and the patient may have noted that her clothes are too tight, but all these are matters belonging to the physical exploration. We need only mention irritability of the bladder and altered or perverted sensations, to dismiss them as of no moment.

Quickening is the sensation imparted to the mother by fœtal movements, from the least tremulous flutter to painful somersaults that keep her awake with acute pain. The motion is usually perceived midway in pregnancy, yet may be felt in pregnancies other than the first as early as the third month, or it may never be discovered throughout. Its importance lies wholly in the mind of the laity. Movement of gas in the bowel counterfeits it, and muscular contractions in the belly wall. Or the sensation may exist only in the imagination. Cessation of motion may be due to death of the fœtus, but temporary or even permanent stoppage of these feelings on the mother's part is not incompatible with a living child.

II. Mammary Signs.

Summary of Signs and Approximate Date.

1. Increased size; nodular feel	End of 2d month.[1]
2. Veins	
3. Changes in primary areola; pigmentation, elevation, wrinkling, follicles	
4. Milk	3d month.
5. Secondary areola	5th month.

1. **The Breast Enlargement** of pregnancy differs from simple fat deposit by the firmness and knotty, uneven character to the touch. This is due to increase in size and number of the glandular lobules, swelling of the connective tissue, and increased deposit of fat between the lobules. In the early months the change is to be distinguished most clearly at the edge, but later the strings of nodules or tiny grape-clusters seem to extend toward the centre. Still later a certain relaxation in the whole breast is seen. The tension may stretch the skin into silvery lines, like the striations on the abdomen, and these constitute permanent markings, often purplish in color.

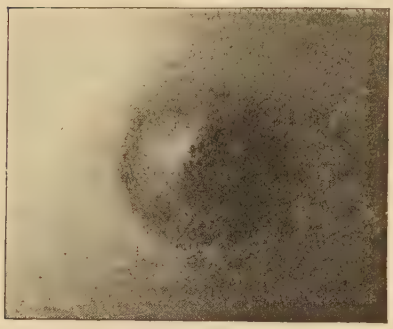
2. **The Veins** enlarge, forming a blue tracery under the skin or slightly elevated above it. They run across the breast and into or around the areola. To bring them out fully the centre of the breast may be circled with pressure for a moment, preferably in a bright light that strikes the surface obliquely.

3. **The Primary Areola.** Pigmentation. The darkened base on which the nipple stands becomes in women of the brunette type the seat of a pigment deposit that renders it not unlike the tint of the negro's skin, ranging from reddish-brown and brown to black, the depth of color usually depending on the patient's complexion. In very light blondes there may

[1] In this chapter the word "month" denotes the calendar month.

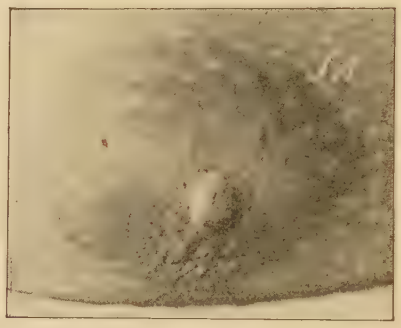
be no discoloration, though often, even when pigment is not visible, reddening or a congested look is noticeable—"the delicate rose-color" of Montgomery.

FIG. 132.



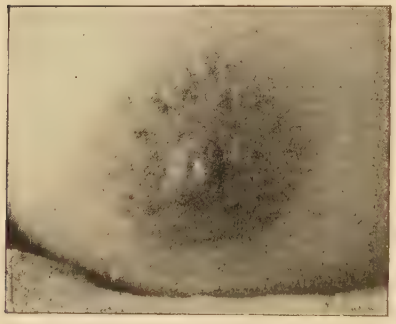
Brunette. Pigmented primary areola; slight secondary areola.

FIG. 133.



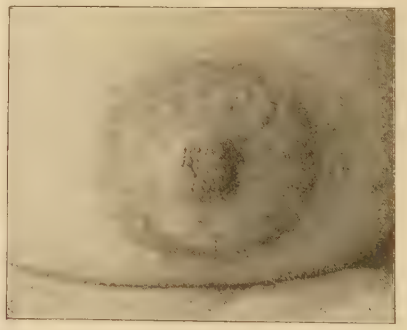
Brunette. Wrinkling of primary areola. Well-defined secondary areola, S. A.

FIG. 134.



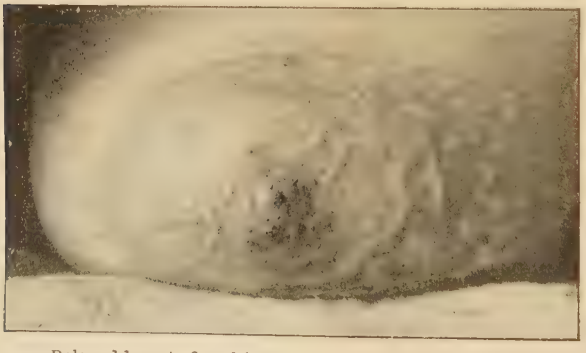
Blonde. Follicles, F. Milk. Faint secondary areola.

FIG. 135.



Blonde. Elevation (E) of primary areola. Follicles. Secondary areola.

FIG. 136.



Relaxed breast of multipara. Veins. Secondary areola.

Elevation of the areola is common in fair women. The puffy thickening and œdema, raising the surface slightly, level or rounded, like a tiny breast on the breast, are readily brought out or accented by gently putting the surrounding skin on the stretch.

Wrinkling or contractility of the areola is produced by the increase in sensibility and size of the subareolar muscle. These bands, mostly circular, are 2 mm., $\frac{1}{16}$ inch, in thickness, according to Testut. Friction or cold or emotion will cause contraction, thereby puckering the skin of the areola over them, and throwing the nipple forward. This is in no sense an erection, although the phenomenon is commonly called erectility of the nipple.

Montgomery's Follicles make up two to twenty small papular prominences on the areola, 2–3 mm. high. They are enlarged sebaceous follicles, and at times moist, lubricating the nipple. Stretching of the skin or action of the muscle of the areola renders them more easily seen.

4. **Milk.** Pressure on the breast and a moment's dextrous stroking of the ducts running toward and beneath the areola will bring colostrum after the third month. There may be branny, dried scales of it on the nipple. It is water-like, or slightly opaque, or later, occasionally yellow. This is the most important of the mammary signs in the woman pregnant for the first time, but, inasmuch as milk persists in the breast thereafter, it gives no help in other pregnancies. As a curiosity, it may be mentioned that milk has been found in virgins, or has been developed in them—or even in the male—by nursing. The primitive man is supposed to have helped suckle the young, when families were larger.

5. **Secondary Areola.** Where the primary areola fades into the skin there appears, at the fifth month, a network of pigment around a certain number of light spots, each tiny circle having for its centre the opening of a follicle. These washed-out spots are rarely absent altogether, usually run about the circumference of the dark surface, and may extend all over the breast. Next to the milk this is the most valuable of the mammary group in the primigravida.

Value of the Mammary Signs. In first pregnancies, with no history of long-continued pelvic disease, the changes enumerated above furnish strong presumptive evidence of pregnancy. They are important in conjunction with other signs. All the indications are rarely present at once in the same case. After the first gestation the signs remain. Various ovarian and uterine disorders, such as tumors, may bring about similar appearances. Masturbation frequently does it, in a certain degree, even where the nipple is not handled.

In practice, breast indications help one in the unmarried suspect. A girl with amenorrhœa and nausea is not to be lightly subjected to bimanual examination or to a question that may be a grave insult; but, under the pretext of investigation of the heart or lungs, the sight of a nipple that shows distinctive alterations will warrant further steps.

Finally, if pregnancy exists, we look to the organ's fitness for function, and teach the patient to bring out a stunted, crevieed, inverted, or tender nipple by massage and traction.

III. Abdominal Signs.

Summary of Chief Signs and Approximate Date.

On palpation :	
1. Size of tumor, and typical growth	From 4th month.
2. Intermittent contractions	4th month.
3. Fœtal parts	5½ months.
4. Fœtal movements	
5. Abdominal ballottement	
On auscultation :	
6. Fœtal heart	4½ months.
7. Uterine souffle	

Preparation for Examination. With clothing unfastened and opened, and all waist-bands loosened, with corsets off and bladder emptied, the patient lies down on the office table or on a firm bed or lounge. A pillow bends the head somewhat forward on the chest, and the shoulders are preferably slightly raised by an inclined plane resembling a bed-rest or by a second pillow under the first. This forward curve of the spinal column does not extend below the scapula. Such a position, with the legs and thighs flexed, relaxes the abdominal walls to their utmost, except very late in pregnancy, when a straighter posture is better. A sheet covers the legs and trunk ; through this or under this examinations may be made in most instances, but one uncovers to listen with the stethoscope or for thoroughness in obscure conditions.

Warm hands have a more acute sense of touch than cold. Cold contacts will cause reflex contraction of the muscular walls. Gentle palpation may bring out all the facts. The skilful use of some force may yet give the impression of light-handedness by gradual increase of pressure. One does not prod with the finger-tips nor play the piano on the surface. With the finger edges touching, the facies of the last phalanges pass along the uterine walls. This is one kind of touch—the circling, sliding contact. The other is a quick push or gentle thrust, to estimate the various resistances. The latter gives more information, but is resented by a sensitive surface.

The examination is made in due order : inspection, palpation, auscultation.

Inspection.

Contour. It is said that in the second month the hypogastric region is flatter and the umbilicus deeper than normal. *Enlargement* of the abdomen begins after the third month, as the uterus rises well above the brim of the pelvis. Regular increase takes place until two to four weeks previous to delivery, when "sinking" or "lightening" occurs, the lower pole settling into the pelvis, and the patient experiencing the comfort of easier breathing and looser waist-bands; but, on the other hand, disturbed by increased bladder pressure. Typical evidences of settling are absent in very many women.

The protrusion of the belly-wall is not symmetrical, being commonly most distinct in the later months to the right of the median line, owing to the torsion of the uterus. Fat deposits in the gluteal regions and over the hips are noticeable in addition to that in the abdominal wall itself. The navel may protrude as the development nears term.

Pigmentation and Striation. Along the median line of the abdomen a dark track of brown is clearly traced from the pubes around the navel and up to the ensiform cartilage. It is discolored most in those with darker skins, and is one-eighth to one-half inch in width. It is part of the pigment dropped in places where capillaries are few, along the front fœtal closure line, on the lips, abdomen, vulva, and perineum (Ahlfeld). The other pigment markings or spots on the face and body are mostly a vegetable growth (chromophytosis). The darkened abdominal line may be found in boys, in virgins, in brunettes, and in pelvic disorders. This change begins in mid-pregnancy.

Streaks or striæ, resulting from stretching of the skin, appear on the lower abdomen. These "lineæ albicantes" vary in color from silvery white through pink to bluish and faint purplish tints. They are wavy and irregular, and in direction commonly lie in concentric zones around a centre just below the umbilicus. They belong chiefly to the last trimester. The skin injury is permanent. On the breasts, the thighs, and the buttocks the markings are also seen.

Value of Inspection Signs. Any other cause for abdominal enlargement or skin tension will produce like effects; therefore, these things are of no import. We enumerate them for completeness in description.

Palpation.

The signs brought out by this means are: Size of uterine tumor and regular growth, intermittent contractions, fœtal parts, fœtal movements, and abdominal ballottement.

Size. The fundus may be felt as it begins to rise two or three fingers above the symphysis in the fourth month (sixteenth week). At about the sixth calendar month (twenty-sixth week) the navel is reached, although this landmark varies so greatly in its distance from the pubes and ensiform that it constitutes a measure of no great accuracy. The ensiform is reached with the maximum height at eight and one-half months (thirty-sixth week), while at term the rounded upper limit of the uterus is somewhat lower. To find the fundus most readily the hand is laid transversely above the expected level, and its ulnar border depresses the abdominal wall; this edge works slowly downward until the uterus is capped by the bowed hand.

To be of value the development of the organ must be progressive and correspond in a general way to the supposed duration of pregnancy as evidenced by other signs. Advance is most rapid in multigravidæ, particularly where the abdominal muscles are lax, the whole organ standing high out of the pelvis; with twins or hydramnion, and in vesicular mole. In certain cases no sinking of the fundus occurs, nor is it found where the muscular layers lack tone, or where an obstruction or a placenta holds the presenting part up out of the pelvis. The factors affecting the height are so various that exact figures possess scant value.

Incidentally note is taken of pendulousness of the abdomen, excessive fat deposit, diastasis of the recti muscles, and tumors in the uterine walls or in the neighborhood.

Fœtal Parts. The characteristic to the touch which differentiates this tumor from other smooth, ovoid, or pear-shaped semi-fluctuating

cyst-like growths, is that some parts are harder, some softer; that the solid parts are of various sizes; that these surfaces and knobs can be identified as actual parts of a child—more particularly as the limbs and head and back. These landmarks may disappear under a general resistance as the womb-wall contracts, to reappear as the tension passes off. Occasionally the face or the feet may be distinctly recognized.

Fœtal parts clearly felt furnish one of the two or three best signs of pregnancy. It is most uncommon to find a tumor bearing distinct resemblance in shape to a fœtus. In cases of excess of liquor amnii or tender or tense uterine walls, one may be unable to outline the child. Fœtal parts may be detected in the sixth month or a little earlier.

Fœtal Movements. The hand laid quietly on the abdomen detects a thrust or push within the womb. Early, it is felt as the gentlest of throbs. Later the motion is either general or local; either the entire body changes its position by partial rotation, with a rolling, sliding motion, or else quick blows are dealt at one or more spots; or, finally, a prominence travels along under the lifted skin. To bring out such action in a quiescent fœtus one may have to gently push or toss the child. The motion is most easily developed at one cornu where the feet are found.

This sign, when clearly detected by the examiner, ranks with the last in importance. It may be simulated by bubbling of gas in the bowel or by localized contractions of the abdominal muscles. These resemblances are said to be occasionally very deceptive, and women themselves are not infrequently deceived, but patience should always give the medical man certainty. Sometimes the motions are rhythmic. Failure to detect movements does not necessarily mean a dead child nor exclude pregnancy.

The date of detection depends on one's skill, in part. By the time the fœtus is a foot long the impulse is vigorous enough to feel—that is, by the sixth month—often earlier.

External Ballottement. This is the sensation imparted by a displaceable mass floating more or less freely in fluid. A hand on either side of the fundus, the operator facing the mother's face, may be able to push an irregular bulk to and fro; or the fœtal part may be rapidly moved under the hand; or, typically (therefore seldom), the fingers may, with a light, quick thrust, drive away a ball that bobs back again against their tips. This distinctive "dipping" and return, or repercussion, is only felt by the route of the abdomen in cases with abundant amnial fluid, or in thin persons, in the fifth month, through the fundus. The best demonstration of this sign is to be had when the head is in the fundus and is cast to and fro as it balances over the shoulders.

The date of detection of this form of tossing is usually after the uterus has risen well into the abdominal cavity—the sixth month. The value of the sign is great, and only pedunculated tumors or wandering organs like the kidney are likely to simulate it.

Intermittent Contractions. A rhythmic and painless hardening of the uterine walls occurs every five to ten minutes, lasting from one-half to five minutes. The contractions may be elicited by friction or by the touch of the cold hand. These alterations in tension are noted as soon as the fundus is high enough to grasp—that is, from the fourth month;

but by conjoined manipulation are appreciable from the earliest beginnings of pregnancy.

This sign has a definite value as showing a condition of hypertrophy of the muscular wall of the uterus, and because the disorders that likewise develop this reflex are infrequent. A uterus distended by retained menstrual blood (hæmatometra), or by a soft uterine fibroid, will act in the same manner. A greatly distended bladder will give the same sensations.

In practice the muscular contraction is of service also, because the rigid round ligament gives us knowledge of the seat of the placenta, information especially desired in case of Cæsarean section.

Percussion is infrequently employed because we can map out the gravid uterus otherwise. In tense abdomens it serves. It may be stated as a rule that after the fifth month the uterus is always in contact with the front wall of the trunk-cavity with no intestinal loops intervening.

Auscultation.

The ear brings out four evidences of pregnancy: Fœtal heart, uterine and umbilical murmurs, and fœtal shock.

Fœtal Heart. The sound is generally double, like that of the adult apex, and at a rate nearly twice that of the maternal pulse. It has been often compared to the muffled tick-tack of a watch under a pillow. A clearer notion may be acquired by the student who listens through an infant's back. To count it calls for practice on his part, but skill comes with persistence and arms him for two important occasions.

The rate is between 120 and 150, and may be increased by the activity of the child and by fever of the mother. The rapidity is greater at the beginning of a pain, slowing as the pressure increases (seldom dropping below 100), even ceasing momentarily at the acme. Variations of 20 beats in the same fœtus are frequent. Sex cannot be determined by the rate. Boys and larger children were supposed to have slower heart-action than girls and smaller children, and the percentage does fall a little in their favor, but the Frankenhäuser theory, that this is reliable or even an approximate index of sex, is discarded.

The heart is heard most commonly between the navel and the anterior superior spine of the ilium on the left side, because the back of the child is located there in the usual position, the left-occipito-anterior. If the previous palpation has indicated that the back will be found in some other place, we listen in that spot, and confirm the diagnosis of position. In the flexed fœtus the heart is placed as near one extremity as the other; it is heard below the navel when the head presents, because the head sinks into the pelvic brim. Should the breech present, the focus of greatest intensity late in pregnancy will be above the umbilicus or at its level. There is some property of the living tissues that prevents the heart from being heard over an area larger than 2 to 4 inches, 5 to 10 cm. A second focus may be detected at the spot where another part of the child presses against the wall, or in case of twin pregnancy. Faint hearts are heard over a small area. Occasionally a wide diffusion is encountered.

The date at which the heart may be heard is a little after mid-preg-

FIG. 137.

Defective method of listening to fœtal heart; the neck is bent, the middle ear congested. Examination is here shown on the low cot, as it corresponds to the bed or sofa in private practice.

FIG. 138.

Defective method of listening for the fœtal heart by standing and leaning over. The fulness of the cerebral vessels caused by this position is indicated in the distended veins on the forehead.

nancy; the time is somewhat dependent on the skill of the observer. It is said to be audible in some cases as early as the fifteenth or sixteenth week.

In value, no sign compares with this. It is certain. The chief fallacy lies in mistaking for it the aortic pulsation transmitted through the uterine mass, or arterial pulsation on its surface, or the sound of the maternal heart. A finger on the radial of the mother establishes the connection with her heart, or the reverse. Moreover, a transmitted maternal cardiac impulse grows stronger in tone as the ear works upward toward her chest. Occasionally one finds that he is listening to the pulse in his own ears. The only troublesome uncertainty will occur when the mother's heart is acting excitedly at about the same rate as that of the child, as after long labor or hemorrhage.

FIG. 139.

Better position for listening to the fœtal heart; straight neck, easy posture, fingers on radial. The assistant presses on the fundus.

The heart is rendered faint or inaudible by an occipito-posterior position, a very fat abdominal wall, excess of liquor amnii, anterior attachment of the placenta, by loudness of the uterine souffle, or persistent noise of gas in the bowels. Death of the child does away with this sound, of course; but repeated observations of such absence may be necessary for positive diagnosis, together with default of movements, lack of tone in uterine wall and breasts, and the recession of other signs.

Method of Examination. Prepared as described on page 131, the patient is to lie preferably where she is accessible on both sides, as on a table or couch. The stethoscope is used for early or difficult cases; but on this yielding surface many observers find that more can be accomplished with the ear. It is expedient to train the ear, for

one does not carry a stethoscope in an obstetric bag, and the most important facts obtainable from fœtal heart-sounds are those gotten in the systematic examinations during the progress of the labor, namely, concerning the danger to the fœtus or the need of prompt interference. A single unstarched thickness is not a hinderance to auscultation, as a rule. If the listener stands and bends over, or if his collar presses against the jugular vein, congestion of the inner ear will interfere with fine hearing. To hear best, if standing on the left of the patient (or with a better right ear), one kneels at the edge of the bed near the patient's shoulder, facing toward her feet. The right ear is laid rather firmly against the lower abdomen, compressing the fat layers. To auscultate the right side one may kneel opposite the hips and reach across the patient at right angles, or pass to the other side. A relatively long count is desirable—say, thirty seconds—and should gaps occur in the succession of the sounds, one counts steadily across them at the same rate. A hand placed on the fundus, pressing toward the pelvis, will arch the child's back up toward the listener's ear. Patience, and persistence, and favorable conditions are all requisite at times, while a room without a clock and away from street and house noises may be necessary.

Apart from our subject, the fœtal heart has great value in the determination of presentation and position; of plural pregnancy; in deciding whether the fœtus is alive or dead; as a danger signal in labor, a rate persisting below 100 or near 200 calling for interference to save the child.

Uterine Souffle. A murmur synchronous with the mother's pulse is heard along the left side of the uterus. It resembles the bruit in the neck of anæmic girls, and the sound is of a quality entirely unlike the tap of the fœtal heart. If the hand is laid in an arch over the ear and its back lightly brushed with the finger-tip, a semblance of this murmur may be had. Its source is the blood-rush in the enlarged and tortuous uterine vessels; it is usually heard loudest, therefore, along the sides of the uterus, and particularly along that side, the left, which is turned toward the anterior abdominal wall. Here the stethoscope serves best, as the murmur is first hunted for in the sulcus above the middle of Poupart's ligament, and from that point upward, with rather firm pressure. The murmur is heard earliest in the middle line. Late in pregnancy it may be found all over the uterus; though often it is entirely wanting, or, more commonly, is capricious, appearing and disappearing, being strongest during the early part of a contraction. It grows louder as pregnancy advances, and is most marked in anæmic women.

The uterine murmur becomes audible during the fourth month. It persists after the delivery of the placenta. It is a valuable sign of an enlarging uterus, but lessened in importance as proof of pregnancy by its presence with large uterine fibroids, or even in association with ovarian cysts or chronic metritis.

Funic Souffle. The umbilical murmur is synchronous with the fœtal heart, and heard usually over the child's back. It is produced by tension, pressure on and displacement of the cord, originating, as a rule, in the umbilical vein (Winckel). In some cases it may originate in the heart itself—even in an endocarditis (Bumm). The sound is heard more frequently when the cord is coiled about the fœtus, when the cord

is abnormally short or long, or when it is deformed—*e. g.*, when the insertion is velamentous. Hence, this bruit furnishes an index of a certain amount of danger to the child, according to Winckel. It is heard after mid-pregnancy, but is relatively rare in the writer's experience.

Fœtal Shock. In listening with the stethoscope as early as the third or fourth month (fourteenth to sixteenth week) the trained ear may sometimes get the tiny thud, with the sound that accompanies it, produced by fœtal impact. The tap of the finger on the back of the hand held near, but not in contact with, the ear, is not unlike it. Winckel says it occurs in 10 to 15 per cent. of all cases. Gas moving distantly in the bowel somewhat resembles it.

IV. Pelvic Signs.

By vaginal and abdomino-vaginal examination the chief indications of pregnancy are: Purplish hue; softened cervix; compressible isthmus; bulging, elastic corpus; vaginal ballottement; fœtal parts.

Method of Examination. The details concerning loosened clothing, coverings, and the dorsal posture, with elevated head and shoulders, have been given on page 133. Just before lying down the patient is requested to urinate. When an early diagnosis is urgently desired, and the rectum is loaded, an enema may be given; or if the bowels are much distended with gas a second examination is asked for, and a three-day diet, mostly of meat, fish, eggs, and milk, is ordered, together with a laxative, and, perhaps, a tablet containing charcoal, pancreatin, bismuth, and ginger. To lift the small intestine out of the pelvis and secure access to the rear of the uterus, particularly in retropositions, the injection of air into the rectum with the patient in the knee-chest or latero-prone posture is worthy of trial (Kelly). Nitrous oxide or chloroform are final resorts. By all these means tension is lessened and the reach down into the pelvis facilitated without some of the harsh methods originally counselled by Hegar.

In order to put the muscles of the pelvic floor and those of the abdominal wall, as well as the adductors, at a disadvantage, the patient is brought down to within a foot of the near edge of the table, the feet placed eight or ten inches apart, and the knees spread abroad to their utmost. If a bed is used it should be firm, that the buttocks may not sink into it. The patient lies at a right angle with its length. Five minutes' scrubbing of the hands should be a routine preliminary to vaginal examination, because of the special susceptibility of the gravid woman to infection, because the finger may need to explore within the cervix, and because, if premature interruption of the pregnancy should soon occur one might have infected his patient. The vulva is cleansed. One passes the finger in by sight in order to make no unnecessary contacts, especially with an imperfectly cleansed anal region; the left hand draws the labia wide apart so that the first contact of the examining finger or fingers will be with the hymen or the vaginal wall inside it. Here again, by gentle firmness, a long reach is practicable, the web between the fingers carrying the perineal body far backward and inward.

If possible, the uterus is gently and quickly caught between the two hands and examined. If out of easy bimanual reach, the finger tips are slipped beyond the cervix and hooked forward, lifting the uterus bodily toward the anterior abdominal wall through the intervening intestinal coils. The outer hand depresses the hypogastrium to reach low down on the back of the uterus, or gently makes circling massage movements with gradually increasing pressure as the muscles yield. The patient is told to cough or breathe deeply, or her attention is side-tracked by a question. In these ways, quickly tried, the hands, one on each face of the uterus, reach as far toward the cervix as may be. Beginning at the cylindrical neck, the anterior and posterior surfaces are examined from cervix to fundus, for compressibility just above the cervix, next for bulging of the walls of the body, following the profile and estimating any increase in thickness of it, determining at the same moment its consistency, whether resiliency is present or not, and, lastly, swinging the body from side to side over the stationary inner fingers to appreciate breadth and the denser spot. The cervix should be palpated at first no more than is necessary in order to identify it, for manipulation here quickly induces intermittent contractions, whereby the organ hardens and some of the signs disappear. As an alternative, the uterus may be toppled over backward and the thinned isthmus brought between the fingers of the two hands.

Whenever the fundus lies in the sacral hollow and cannot be swung forward, a tenaculum hooked into the cervix will draw down the uterus within reach of vagino-abdominal or recto-abdominal palpation.

Inspection of the cervix for color-changes, with the speculum, is next in order. A miscarriage subsequent to a speculum examination may be attributed by the patient to the physician's "instruments" either through ignorance or by a woman who afterward induces abortion. With certain patients one avoids any examination except the bimanual, which can do no harm.

Rectal examination gives little information in normal cases, but is necessary in uterine or ovarian displacement, or to outline and differentiate tumors, exudates, or hemorrhages.

Purplish Hue of the Vagina. Venous congestion from hypertrophy of the vessels runs up the entire vagina. On drawing the vulva open the dusky discoloration is seen readily on the anterior vaginal wall below the urinary meatus. A faint venous color may show itself by the end of the first month. Chadwick showed that 80 per cent. of pregnant women developed the color by the end of the third month. The fallacy is that heart disease, varicose enlargement, and the like may produce analogous coloring. Late in pregnancy the pudenda are relaxed, soft, and swollen, while moistened by free secretion of mucus.

Purplish Hue of the Cervix. "A more or less marked lividity of the vaginal portion of the cervix may be observed almost from the first month after conception. The purplish color of the cervix is not only developed earlier, but is more constantly present than that of the vagina" (Jewett).

Enlarged arteries are felt pulsating in the vagina, often suggestive of fœtal movements or ballottement.

Early Changes in the Uterus. Six or eight weeks after the beginning of the last menstruation the following conditions are found:

I.	In the isthmus between body and cervix	Compressibility.
II.	In the body of the uterus	Elasticity or doughiness.
III.		Bulging, symmetrical or irregular.
IV.		Density differences between right and left sides.
V.		Furrows or folds.
VI.		Intermittent contractions.
VII.	In the cervix	Softening.
VIII.		Purple hue.

Of these signs, the first three are most valuable; in frequency they rank in the opposite order, namely, bulging, elasticity, compressibility.

Compressibility of the Lower Uterine Segment. Just above the cervix and between it and the rounded body above there is a

Fig. 140.

Changes in the pregnant uterus of the sixth week, on the left when partly relaxed, on the right when contracted. Diagrammatic side view.

striking absence of resistance, the fingers of the examining hands coming together closely. When the sign is fully developed the thickness is no more than that of a visiting-card. In its extreme form the corpus seems like a tumor pedunculated. Often the yielding sensation is partial, yet unmistakable. It is accounted for by reference to the section of Pinard's uterus (Fig. 141), imagining the bulk of this ovum as somewhat less, for the enormously thickened mucosa contains many dilated and irregular blood-sinuses which reach their maximum development at the end of the second month, and the decidua is very pulpy and soft. Well-defined compressibility was found by the writer in two-thirds of a series of fifty cases.[1] Of all the bimanual signs of early pregnancy, this is the most important. It is known as "Hegar's sign."

Bulging of the Corpus Uteri, Symmetrical or Irregular. On the front or back of the uterine body a generally rounded prominence is detected, resembling the blunt end of a hen's egg, but overhanging the retreating lower uterine segment very distinctly.[2] When

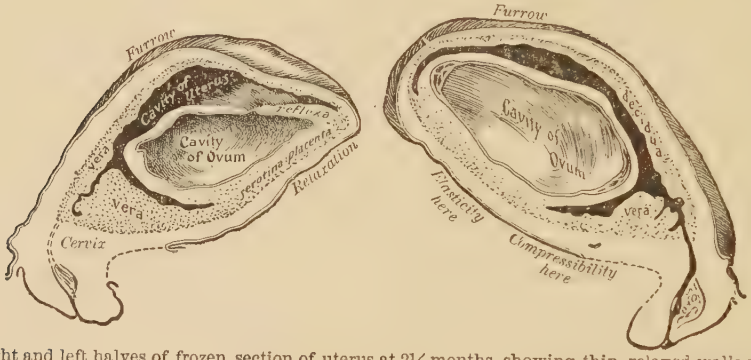
[1] The Editor of this System taught this sign to the writer long before Hegar's assistants published it. Jewett, Therapeutic Gazette, July 15, 1891.

[2] Grandin first insisted on this sign; N. Y. Med. Record, 1886, p. 241.

in front the profile is that of a full-breasted, corsetted woman bending forward. This rounded cornice, or overhanging, may project in any direction or in all directions. No change of early pregnancy is more constant than this.

The other form of prominence is lop-sided. A circumscribed portion, such as half the uterine body, or one horn, or one side near the cervix,

FIG. 141.

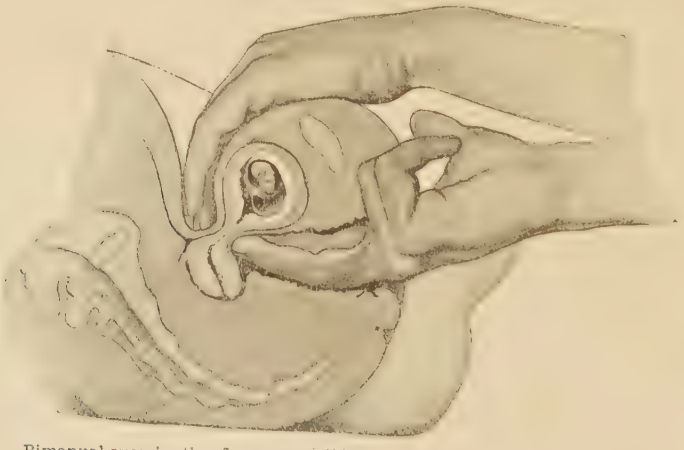


Right and left halves of frozen section of uterus at 2½ months, showing thin, relaxed walls and thick decidua. (PINARD.)

is rounded and protruding. The protuberance will constitute the elastic portion, cut off by a groove from the flatter, thinner, denser part.[1]

Owing to the presence of INTERMITTENT CONTRACTIONS the signs to be found in a given uterus are subject to some variations. During

FIG. 142.



Bimanual examination for compressibility of the isthmus at the sixth week.

relaxation the body of the organ is either soft, compressible, and flattened, or else doughy. As contraction comes on the body becomes elastic to the touch and more globular; while at the height of the con-

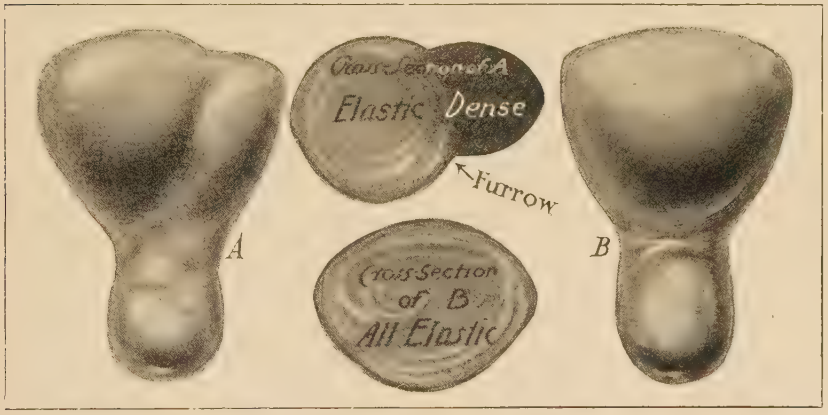
[1] Dickinson pictured this in 1893, in the N. Y. Jour. Gyn. and Obst. Braun-Fernwald (Wiener klin. Wochenschr., 9 März, 1899, and Monatsschr. f. Geb. u. Gyn., May, 1899), and Piskaček (Wien, Braumüller, 1899, Ueber Asladungen umschriebener gebärmutter Abschnitte) have elaborated these findings.

traction the whole body is rigid and hard. The change from one of these conditions to the other may take place under the finger. (Fig. 140.)

Elasticity. If the empty uterus were always as hard as a raw potato, and the gravid uterus elastic as a rubber ball, a diagnosis of early pregnancy would be easy. Unhappily the conditions are not so simple. The corpus uteri of gestation, when of typical consistency, is resilient, distinctly suggesting "the fluid elasticity of the growing ovum" within. In this condition one most frequently finds it, and the finding constitutes one of the most easily determined and most valuable of the early signs.

Density Differences between Right and Left Sides. In a certain percentage of uteri of early pregnancy one portion of the body is dense, hard, or resisting, and the remainder, usually the larger portion, is elastic. (Fig. 143.) Between these two parts an upright or oblique or crescentic furrow runs as a clean-cut boundary. These characters may temporarily disappear during a contraction.

Fig. 143.



Front views of uteri six weeks pregnant, showing two common types.

A. Prominence and elasticity on one side, density toward the other horn, with a furrow between.
B. Bulging and elasticity symmetrical and anterior.

Furrows or Folds. Grooves, long or short, straight or curved, may run across the front or back of the corpus or fundus. A double groove will define a fold, and the fold may be hard on top, constituting a ridge. Folds and grooves run longitudinally or obliquely more often than across.[1]

Size. The increase is fairly regular, and may be determined by comparison of findings three weeks apart. Unhappily the finger has not a memory of that duration. Increase in length up to the sixth or even the eighth week is very difficult to estimate. But with the increase in thickness it is different, since the antero-posterior dimension of the corpus is readily palpated, and expansion is appreciable at the sixth or eighth week, as the body then measures 2 inches (5 cm.) from front to back. At the end of the third month the organ is 5 inches (12.5 cm.) in length, 4 inches wide (11 cm.), and 3 inches thick (8 cm.); that is, about the size of a man's fist tightly closed.

[1] Dickinson (N. Y. Jour. Gyn. and Obst., June, 1892), confirmed by Hegar (Deutsche med. Wochenschr., 1895, No. 35).

The date of appearance of the signs that are determined by conjoined manipulation is the sixth week on an average; but practice enables one to find them in favorable cases as early as the third or fourth. At the eighth week they ought to be distinct. Later the ovum fills the cavity more and more completely, and compressibility is lost after the third month. The asymmetries of growth and density may persist to the fifth month.

Softening of the Cervix. After the first month the consistency of the cervix changes. First a velvety feel like that of the mucous lining of the cheek is noted, covering the hard knob beneath. The softening progresses upward rather slowly until the sixth month. At the eighth month the whole cervix has become yielding, so that the finger passes through the canal without resistance. Indeed, at term there seems to be no projection, the cervix having the same consistency as the vaginal wall.

"A similar softening occurring from pathological causes lacks the same progressive character." Conversely, a hard cervix and especially a small firm cervix rules out a supposed late pregnancy, and thus, in the differential diagnosis of obscure abdominal tumors, becomes a factor of no mean value.

The Possibilities of Error connected with the early signs are as follows:

In the non-gravid or virgin uterus somewhat similar conditions may be found by skilled touch when a complete examination is rendered easy by an abdominal wall that is thin and relaxed in a patient free from sensitiveness. Considered in profile, the anterior surface of the virgin uterus is approximately flat or slightly rounded, whereas the posterior face shows a distinct convexity. During the intermittent contractions that can be appreciated by palpation in many uteri in the unimpregnated state a more globular form and a hardening of the whole uterine body develop, the antero-posterior diameters especially increasing.[1] These vacillations in consistency have, however, but a short range, elasticity and bogginess of the body being infrequent, and thinning at the lower segment absent (except in some anteflexions). Asymmetry, or partial division of the corpus into sections or chambers by a palpable furrow, or into ridges, while it is not uncommon in the non-parous uterus, presents no striking contrast of consistency between the right and left sides. Softness of the cervix due to œdema alone, or the dusky hue due to erotic feeling, are not accompanied by some of the other pregnancy signs.

Anteflexion with atrophy of the junction of cervix and body will yield the hour-glass isthmus with a body rounding out above the thinned angle. Here the smallness of the body, together with its hardness, must exclude pregnancy, as well as the lack of increase in size or elasticity proved by an examination two or three weeks later. Hyperæmia, hyperplasia, or subinvolution will exhibit an enlarged body; but the history and symptoms of chronic uterine disease, the resistance to the touch, and the absence of Hegar's sign, in conjunction with the stationary character of the findings, will exclude pregnancy. Retroversion with flexion will present swollen conditions resembling the alterations of pregnancy. Reposition—and consequent shrinkage—may be neces-

[1] Lindblom, Archiv f. Gyn., Jan., 1892; Acconci, Turin, 1881, epitome in Centralblatt f. Gyn., 1892, No. 8.

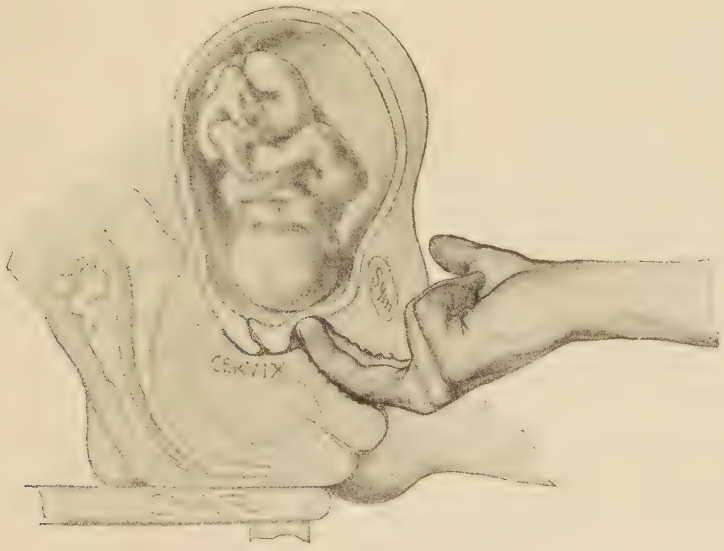
sary before the diagnosis can be settled. A soft submucous fibroid causes hemorrhage rather than amenorrhœa.

Internal Ballottement. One or two fingers against the anterior vaginal wall close to the cervix give a sudden impulse to that part of the fœtus resting against the anterior uterine wall. The child floats up through the liquor amnii, and after a slight and momentary excursion settles back against the finger-tips, repercussing with a very gentle tap. The departure alone, without evident return, is enough to constitute this sign. In order to develop it the long axis of the uterus should be vertical, and this is brought about by a posture half-way between sitting and lying down, on the edge of a bed or table.

The value of the sign is very great, but there are others that develop much earlier that are of greater import. It is detected when the child is large enough to impart sensation to the finger, and ceases when the bulk of the fœtus too nearly fills the cavity, being present, then, during the fifth and sixth months (twenty-one to twenty-six weeks). The fœtus is too light before this time, and there is too little fluid later. Ballottement is absent with scanty liquor amnii, with twins, and with the placenta low in front.

The possible but infrequent fallacies in ballottement are an anteflexed uterus, a pedunculated cyst or fibroid, internal projections of large cysts, vesical calculus with the bladder full, a kidney floating low, pulsation of the uterine artery (Jewett).

FIG. 144.



Internal ballottement, semi-recumbent posture, at sixth month.

Fœtal parts may be felt through the vaginal and uterine walls by the twentieth week (fifth month, or earlier); the head or breech made out by the twenty-eighth week (six and one-half calendar months), and reached directly through the cervix during the seventh month (Winckel).

PREGNANCY—THE SIGNS BY MONTHS.

Weeks.	Lunar Months.	Calendar Months.	History.	Mammary.	Abdominal.	Pelvic.
1						
2	1	1	Suppression of menses (throughout).			
3						
4						
5						
6	2	2	Nausea.	Size—nodules. Veins. Primary areola, pigment, follicles, corrugation.		Uterine body bulging,—elastic or doughy; isthmus compressible; cervix softening.
7						
8						
9						
10	3					
11		3	Nausea.	All, throughout pregnancy.		As before.
12						
13				Milk.		Purplish hue.
14						
15	4		Nausea passes.		Fundus rises.	Cervix softens progressively.
16		4				
17					Fœtal shock.	Compressibility lost. Fœtal parts.
18						
19	5				Pigmentation.	
20		5	Quickening (4½ *months*).	Secondary areola.	Intermittent contractions. Fœtal parts. Fœtal heart. Uterine souffle. Funic souffle.	Internal ballottement.
21						
22						
23	6					
24		6		All, throughout.	Fœtal movements. External ballottement. Fundus at navel. Striæ.	Internal ballottement.
25						
26						
27	7					
28		7			All, throughout.	Ballottement lost. Cervix patulous, pulpy.
29						
30						
31	8					
32		8				
33						
34	9					
35						
36						
37		9				
38	10					
39						
40						

DIFFERENTIAL DIAGNOSIS OF PREGNANCY.

In the early months:

Anteflexion of the uterus with atrophy of the angle and hyperæmia of the body may closely counterfeit the organ six weeks pregnant. The peculiar elasticity of the corpus uteri and its ready variations from relaxation to firm contraction are missing, while the persistence of menstruation, even though scanty, as well as the stationary character of the findings, as shown at a later examination, will make the distinction.

A pedunculated fibroid of the anterior uterine wall is solid, and, therefore, unlike the corpus of pregnancy in consistency.

An ovarian cyst or a distended *tube* in the cul-de-sac may suggest retroversion of a gravid uterus, especially if moving with the cervix. Their tension and clear elasticity are stable, and more marked than those of the ovum-filled corpus.

Chronic metritis and subinvolution, on the other hand, impart to the finger a firmer resistance, and not a globular shape nor bellying in the antero-posterior diameter, nor do they show compressibility of the isthmus.

In retroflexion the swollen uterus may resemble the gravid organ of the fifth or sixth week, and not until after reposition and shrinkage may the difference be apparent.

The diagnosis of tubal gestation is fully treated of in the chapter on Ectopic Gestation.

In all these conditions experience, expertness, and access to all parts of the pelvis in order to map out the organs may, possibly, be necessary for a diagnosis. A dubious history, and sensitiveness, and resistance may call for repeated examinations or for anæsthesia. One mistake in five, or many blanks, are conclusions to be expected.

In the later months:

General Rule in Differentiating. Three discrepancies are always to be borne in mind as pointing to conditions other than pregnancy:

1. The rate of enlargement differs from that of the pregnant uterus.
2. The size and the period of amenorrhœa do not correspond with each other.
3. The most important signs of pregnancy are absent, namely, fœtal heart, fœtal movements, distinctive fœtal parts, and the external and internal ballottement. Menstruation usually persists. With each of the following disorders it will not, therefore, be necessary to reiterate the above statements.

Fat. The general rotundity of the patient arouses suspicion, while locally the thickness of the deposit may be estimated by lifting a fold or seizing the bulk of the belly-wall between the hands. The whole surface is faintly resonant on percussion. Abdomino-vaginal exploration fails to bring an organ between the two hands, through which any thrust may be transmitted, and the small, hard cervix gives a clue to the size of the uterus. Obesity is a frequent cause of amenorrhœa or scanty flow, and especially when anæmia coexists.

Tympanites. Here the girth is variable from time to time, the resonance is general and obvious, and a firm tumor is lacking. With steady pressure while the patient coughs or breathes deeply, a deeper and deeper

reach sinks the hand toward the spinal column. Again, the cervix has not softened to tally with the bigness of the abdomen.

Ascites. The shape is suggestive, being not prominent, but rather flat in front and bulging on the sides, as the patient lies. Percussion brings out tympany in front and flatness or dulness at the flanks, the level of the flatness changing with changes of posture. In pregnancy it is a curiosity to find any intestinal coils in front of the uterus when the fundus has once risen well out of the pelvis. Suppression of the menses is often seen in dropsy, and the history of disease of the heart, kidney, or liver will indicate the cause.

Ovarian Cyst. In its earlier stages the resistance is most marked at one side of the median line; later it may be central, but this will be after long growth; a monocyst is more smooth, globular, and elastic than the uterus, and fluctuates all over. The most important point lies in the characteristic cyst-sensation imparted to the hands. The uterus, and with it the cervix, is displaced toward the back, side, or to the front, as a finger, following upward from the small, firm external os may be able to ascertain, though the distinction is often most difficult. In the presence of a moderately long pedicle there may be a space between uterus and cyst into which the fingers can press. The gravid organ of the fourth month, rotund, firm, without movements, fœtal parts, or heart-sounds, and with the cervix far back, where it cannot easily be traced as a connection of the mass above, most nearly resembles a cyst which has crowded the womb backward. But the cervix of pregnancy at this stage is boggy on its surface, is usually to be found in the median line, and may be followed up laterally into the body. This body and its changes in consistence are to be studied, the round ligaments located, if possible, and notes made for comparison three or four weeks later. The tension of hydramnion is suggestive of a cyst. Cyst and gestation may exist together and render the diagnosis difficult. Amenorrhœa is not often present in ovarian growths, and the patient has commonly a history of increasing dysmenorrhœa.

Fibroid Tumors. Most growths of this kind are very hard. Some are nodular, and occasionally one bears a likeness to fœtal parts. Careful palpation and bimanual examination must map out the relation between the unsoftened cervix and the tumor or tumors in or on the uterus above. A study of the location of the round ligaments may demonstrate the common asymmetry of enlargement due to fibromata, as compared with the usual symmetry of pregnancy. Instead of cessation of menstruation, uterine hemorrhage is the rule, either periodic or continuous, and if anæmia stops the flow, the arrest is gradual and not sudden. Occasionally the new growth is subperitoneal and pedunculated, or the cervix may be gaping to give exit to a submucous fibroid. When fibromata and pregnancy coexist the tumors grow rapidly, particularly the intramural variety, and the combination adds to the difficulty of the diagnosis. Unless the tumor is very large and low, the purplish hue of the vagina and cervix is not developed in these growths as in pregnancy. In difficult cases, again, the final appeal is to time or to chloroform.

Enlarged Organs. These develop from above downward. The dulness, the line of the lower edge, and the resonant strip below serve to indicate the source of the abdomen's prominence. Encysted dropsy is

rare. Wandering organs, like the kidney and spleen, can be pushed upward. Malignant omental and mesenteric growths are lumpy and fixed, presenting, if large, a marked cachexia late in life.

An over-distended bladder gives a history of short duration, pain, and dribbling. Retroversion, with or without pregnancy, is often its associate. The catheter settles the diagnosis.

Phantom Tumor. In spurious pregnancy, breast changes, the size of the abdomen enlarged with gas and fat, and the imaginary movements have led hysterical and anæmic individuals and women near the menopause or excessively anxious for children into curious errors. The uterus is found to be small, and chloroform may be needed to assure the family of the self-deception.

Hæmatometra. A growth characterized by monthly increase in size, accompanied with severe pains and contractions before the appearance of menstruation at puberty, points to an atresia somewhere between the hymen and cervix. It is very rare. More rarely still the canal may have closed up from injury or disease.

CHAPTER V.

THE DURATION OF PREGNANCY.

The duration of pregnancy cannot be definitely determined because there is no accurate method of ascertaining when fecundation occurs, nor are there any signs at the end of pregnancy that tell how long it has existed. The uncertainty as to the time of fecundation is readily appreciated when one considers that menstruation and ovulation are not necessarily synchronous processes, and that the ovum, as shown by Issmer, may remain alive for sixteen days. This uncertainty is further increased by the fact, noted by Dührssen, that spermatozoa have been found alive in the uterus and tubes twenty-five days after coitus. The possibilities are so varied under such conditions that neither the time of the last menstruation nor the date of coitus, even if only one coitus were known to have occurred, can serve to determine with accuracy the date of the beginning of pregnancy. The lower animals show still wider variations in the time that elapses between insemination and fertilization. In bats, for example, copulation takes place in the fall and fertilization results in the spring.

Clinical experience teaches that notwithstanding these possible variations, fecundation in the human female usually occurs within a few hours after coitus, and more often in the first week or ten days after menstruation than later in the month.

It is probable, though, that variations from this rule are more frequent than is generally supposed. The usual term of gestation is 280 days after the first day of the last menstruation and about 270 days after coitus, Schlichting placing the lowest limit as 236 days and the upper as 334 days. Certain factors of considerable clinical importance have been found by Issmer to influence the duration of pregnancy. In multiparæ it is prolonged from 3½ to 5 days with each additional pregnancy, according as the time is estimated from coitus or the last menstruation. It is also found to depend upon the age of the patient, increasing from four to five days up to the age of thirty-six, after which it gradually shortens. Active exercise was found by both Pinard and Issmer to be an important factor in shortening the duration, thus accounting for the differences that have been noted between married and single women, and between the winter and summer months. It was also found to average two days longer in large and strong than in weakly women, and longer in blondes than in brunettes.

A most important question relates to the size of the child. In the lower animals the duration of gestation varies with their size, being only twenty-two to twenty-four days in the mouse, while in elephants it is 610 days. In the human female, Winckel, confirmed by Enge, Füth, Hostetter, Jacoby and Starke, found from a large series of cases that in 3.15 per cent. the child weighed 4,000 grams or over, and that in 14.5 per cent. of these pregnancy lasted over 302 days—the upper limit legally recog-

nized in Germany at that time (1901). The average delay in all cases with large children was 8.22 days, if computed from the first day of the last menstruation, and six to eight if computed from coitus. The average delay in thirty-one cases personally observed by Winckel, in which the average length of the child was 53.8 cm. and the weight 4,276 grams, was thirty-one days after menstruation and twenty-two after coitus. In general, it was shown that in 71.8 per cent. of cases with large children the duration of pregnancy was more than 280 days after the first day of the last menstruation, and in 62.7 per cent. was more than 270 days after coitus. It was impossible, however, to tell the duration in this way, because in two children of the same weight the periods of gestation may have varied as much as ten days.

Medico-legally, great latitude is allowed, no legal limits being placed in England or America. According to Parvin, it has been judicially decided in this country that pregnancy may last 317 days. Cases in which the evidence is incontestable are reported as lasting from 241 days to 336 days after the first day of the last menstruation.

The probable relation between the size of the child and the duration of pregnancy is also one of great clinical importance, since a routine examination of the fetal head in cases suspected of going beyond the usual time, should determine a more frequent resort to the induction of labor, thus lessening both the fetal and the maternal mortality.

Prediction of the date of labor is essential from the standpoint of convenience and economy, but is difficult to make closer than a week, and in many instances errors of several weeks are unavoidable because of the facts just given.

Most generally relied upon is the menstrual history, according to Nægele's rule, counting back three months and adding seven days. Menstruation, though usually atypical, may be present for one, two or even three months after conception. Fecundation also may take place three weeks or more after the last period. An error of three or even four weeks is occasionally possible, therefore, in the application of Nægele's rule.

Quickening is the event most frequently relied upon by patients for computing the date of labor. But its first appreciation, although looked for in mid-pregnancy, may vary within limits of several weeks, and often is confused, even by multiparæ, with other sensations within the abdomen.

The abdominal examination gives the most accurate data, especially if the physical signs are interpreted in connection with the history. The height of the fundus relative to the umbilicus is fairly reliable, yet the umbilicus is not an absolutely fixed point, and, moreover, the uterus may be abnormally large from the presence of twins or an excessive amount of liquor amnii. Its position, too, may vary with the muscular tone of the abdominal wall and with the relation of the fetal head to the pelvic cavity. A part of the abdominal examination that is commonly neglected because of the supposed difficulty in its execution, is the determination of the size of the fetal head. At the end of the seventh month it is large enough to be readily palpable in most cases, and after that period the experienced obstetrician may derive some aid from the size of the head in estimating the probable date of labor.

If the history and physical signs agree, considerable certainty may be felt: in case of discrepancy, the physical signs are more trustworthy. Occa-

sionally it may be desirable to make a vaginal examination near the approach of the previously predicted time in order to note if shortening of the cervix has begun.

Dührssen, Zeitcshr, f. Geburts, u. Frauenkrankh, XVII., 305.
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CHAPTER VI.

HYGIENE AND MANAGEMENT OF PREGNANCY.

Pregnancy, although essentially a physiological process, finds a large number of women who are physically unprepared for the increased demands that it entails. This may be the result either of hereditary defects or of some visceral insufficiency that has been acquired by errors of diet and hygiene, which have been committed previously without apparent harm. The responsibility, therefore, of the attendant for the safe conduct of a patient through pregnancy is fully as great as for her care during labor and the puerperium.

Personal Observation. In order properly to fulfill this duty the attendant must obtain the previous history and personally interview the patient at regular intervals throughout the entire period of pregnancy. It is only in this way that a correct interpretation can be made of certain symptoms, which often are regarded as physiological, because, individually, they are so frequent and apparently innocuous, but attention to which in the light of our present knowledge may be of signal service in preventing serious accidents. Personal observation of the patient is of more value than the ordinary examination of the urine, which by itself can neither give assurance of the safety of the patient, nor always insure a proper interpretation of her condition in the presence of pathological findings.

Diet. Plain, nutritious and digestible foods of all kinds should be taken at regular intervals. The amount of proteids taken in the form of meat should be limited in most cases; cereals and vegetables may be advantageously substituted. It is especially important that the intestinal tract shall not be overloaded at any time, and on this account it is often a good plan to limit the amount taken at each meal, and, if necessary, to increase the number of meals. In this way the gastric irritibility and repugnance to food in the early months may often be alleviated, and the discomfort from the pressure of the large uterus in the later months be diminished, while nutrition is satisfactorily maintained. Individual caprices of taste and appetite may be indulged so long as nutritious and digestible articles of food are desired, but cravings for indigestible substances should not be satisfied under any circumstances. Fruits of all kinds may be allowed unless there is an individual idiosyncrasy against them. Tea and coffee may be advantageously limited in amount, and in some cases entirely prohibited.

All patients should be encouraged to drink large quantities of water, and for this purpose, if financial circumstances permit, some special form of bottled water may be ordered. Alcoholic beverages need not be prohibited in all cases, but should always be limited in amount. The relation of the diet to the weight of the child was first demonstrated by Prochownik, who had considerable success in limiting the size of the child by withdrawing the carbohydrates and limiting the amount of ingested fluids during the last six or eight weeks of pregnancy, in cases with con-

tracted pelvis or in those who had previously had difficult labors. These favorable results have been confirmed by Temesváry, Paton and Bokelmann. The last-mentioned author, who carried out this diet for twelve weeks in elderly primiparæ, found that labor pains were also improved.

The Gestro-Intestinal Tract. Gastric disturbance at any period of pregnancy is often the premonitory sign of serious trouble, and attempts should always be made to relieve it. The treatment of constipation, which often is the basic factor in more serious troubles, is always required. The use of fruits and cereals may be sufficient, but usually some cathartic must be employed. Cascara, or phosphate of sodium, in one or two drachm doses, sometimes given for a considerable length of time, with or without the administration of grain doses of calomel, at intervals of ten days or two weeks, will usually afford complete relief.

Exercise. It is absolutely essential for a normal course in pregnancy that exercise, regulated according to the patient's previous habits, should be taken. Walking in the open air is the safest and most available form. Women with athletic tendencies must be somewhat checked and made to abstain from the severer forms, like tennis and riding, although it is probable that many of the interruptions of pregnancy ascribed to such causes are really the result of local pelvic disease. In no instance should exercise be carried to the point of exhaustion. It is particularly important that during the last three months, when the natural discomfort from the size of the gravid uterus inclines patients to desist from exercise, that it should be rigidly enforced. Courelaire has noted the favorable influence of exercise in the later months in limiting the size of the child. Dr. É. A. Tucker taught the benificial results of certain gymnastic exercises in helping the head to engage before labor begins. He advised his patients to practice bending the body forward and attempting to touch the floor with the hands without bending the knees a certain number of times each day during the last month of pregnancy. It is desirable that the patient should rest after all forms of exercise. Sufficient sleep is also very essential, and, so far as possible, pregnant women should not have the care of other members of the family who may chance to be sick.

Bathing. The previous habits should be carefully considered in giving advise as to bathing. Cold tub baths are not contraindicated in those who have been in the habit of taking them prior to pregnancy; their use should be continued, except that the temperature should not be lower than 60 F. For those unaccustomed to cold tub bathing sponge baths may be advised in order to keep the skin in proper condition. De Niet found that by the use of full tub baths at temperatures ranging from 65° to 70° F. four times a week the metabolism was distinctly improved.

Clothing. Loose-fitting and comfortable clothing should be worn, but hanging the skirts from the shoulders instead of from the waist, although theoretically desirable, is so great a departure from the present custom that insistence upon it will usually result in more trouble for the attendant than benefit to the patient. Corsets that fit well, especially the straight front variety, may be worn during the first four months. As soon, however, as the abdomen begins to be appreciably enlarged it is usually best to discard them, although some patients feel distinctly more comfortable with them for two or three months longer. They may not be harmful if the physician is assured by a personal examination that they are not

laced too tightly. Most multiparæ and many primiparæ feel the need of a support; some form of abdominal bandage affords relief from backache, and renders them distinctly more comfortable. An abdominal corset which laces up behind over a long extent of surface like the ordinary corset, with elastic gores over the hips so as to fit more perfectly as the abdomen enlarges, best serves the purpose. The so-called combination suits are best adapted for garments to be worn next to the skin, for which linen mesh is excellent material.

Breasts and Nipples. Comparative little can be accomplished by any specific treatment of the breasts and nipples, except frequent bathing to prevent the accumulation of crusts from the drying of the secretion which in many instances is considerable. Small and slightly protruding nipples may be lengthened somewhat by gentle traction practiced two or three times a day during the latter part of pregnancy. Nipples that are markedly retracted can not be appreciably improved. Daily bathing with a mild solution of alum in 50° alcohol will help to harden them and thus aid in the prevention of fissures during the puerperium.

The Urine. Examinations of the urine should be made throughout pregnancy at intervals which must be definitely stated by the attendant. The knowledge, however, obtained from these examinations without a personal observation of the patient will be of little value in assuring the attendant that the patient is in normal condition. The safety of the patient demands that the examination be made every two weeks or oftener during the last three months, and in order to properly interpret the findings, a knowledge of the patient's diet and her habits in regard to exercise is necessary. Certain details also in regard to the collection of the specimens must carefully be followed. A twenty-four-hour specimen is necessary for all examinations; the amount may be noted by the patient after she has been instructed as to the significance of variations. Clean receptacles must be used, and in order to prevent fermentation, a preservative, such as a teaspoonful of boric acid or chloroform is sufficient. This should be placed in the receptacle into which the urine is passed. On account of the frequent presence of vaginal discharges the patient should be instructed to cleanse the external genitals before micturition. Neglect to do this undoubtedly accounts in many cases for the presence of a small amount of albumin. The ordinary clinical examinations should include the determination of the specific gravity, of the presence of albumin and sugar, of any excess of indican and a microscopical examination. The determination of the amount of urea by the hypobromite method has been shown by Ewing and others to be of little value. Repeated examinations under the above conditions may be of the utmost aid, if considered in conjunction with the clinical symptoms. It is of the greatest importance, however, to realize that serious conditions may arise when the ordinary clinical examination of the urine is practically negative.

The Hygiene of the Pelvic Organs. The use of vaginal douches is unnecessary unless there is a discharge. Abnormal discharge has the same significance as in the non-pregnant state, and demands an examination to determine its source and cause. For douches only mild solutions of boric acid or normal saline solution should be employed. Sexual intercourse may not be positively harmful in the early months, but in the later months should be forbidden.

The Nervous System. Decades of obstetric teaching have succeeded in impressing both physicians and the laity with the idea that a woman's mental condition during pregnancy differs normally from that of the non-pregnant state. She is described as more irritable and emotional, and occasionally subject to delusions that border on insanity. The writer is convinced that this is erroneous, and is only another example of confusing pathological with physiological conditions. The firm assurance of the attendant that pregnancy is a physiological process, requiring only the observation of certain precautions to make it safe for both mother and child, will usually allay any fears that may previously have been acquired.

Examination of the Patient. A general examination should be made as early in pregnancy as possible, especially of the heart and lungs, because pregnancy has an important relation to diseases of these organs.

Obstetric examination is usually unnecessary until the seventh month, when the fetus is viable and of sufficient size to be readily palpated. At this time both an abdominal and vaginal examination is required.

Abdominal examination should include inspection, palpation and auscultation. The discovery of any abnormality will permit at this time of proper consideration of both mother and child. Practice in palpating the fetal head will often aid the attendant in confirming or denying the patient's history as to the duration of the pregnancy. The position of the fetus, however, is not yet sufficiently fixed, and, therefore, a second abdominal examination should be made in the middle of the last month.

The Vaginal Examination. It is inadvisable to conduct a patient through pregnancy without at least one vaginal examination, which is best done at the time of the first abdominal examination. A second examination in the last month is not always essential, but often the relations of the fetal head to the pelvis may better be determined in this way, and thus enable the attendant to more confidently begin the conduct of labor.

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PART III.

PHYSIOLOGY OF LABOR.

CHAPTER VII.

THE MECHANICAL ELEMENTS OF LABOR.

THREE factors are concerned in the mechanism of labor. They are: 1. The Expelling Powers. 2. The Passages. 3. The Passenger. An intimate knowledge of these elements of the parturient process is the first essential to a proper understanding of the course and management of both normal and abnormal labors.

I. The Expelling Powers.

The expellent forces are three: *a*. The contractions of the uterus. *b*. The action of the abdominal muscles. *c*. The action of the pelvic floor.

(*a*) **The Uterine Contractions.** The chief expelling power is the contraction of the muscular walls of the body of the uterus, or, rather, of the upper uterine segment.

The uterine contractions are *involuntary*, being mainly under control of the sympathetic nervous system. Yet, though independent of the will, they may be strengthened, enfeebled, or wholly arrested by emotional influences. The uterus has two motor centres, one in the medulla oblongata and one in the lumbar portion of the cord; apart from these its contractions are influenced to some extent by the action of its own ganglia. Routh observes that direct communication with the brain is not essential to co-ordinate uterine action, though the brain seems to regulate the pains. Direct communication between the uterus and the lumbar enlargement of the cord probably is essential to co-ordinate contraction.

The contractions are assumed to be *peristaltic*, the wave beginning at the fundus, or at the cornua, and sweeping almost instantaneously over the contractile segment. This peristaltic character of the uterine contraction is marked in the tubular uterus of some of the lower animals, but is inappreciable in the human species.

They are also *intermittent*. At the beginning of labor they recur at intervals of from fifteen to thirty minutes. The intervals shorten as labor progresses, and at the acme of expulsion they do not usually exceed two or three minutes; frequently at the close of the perineal stage they are practically continuous.

Each uterine contraction presents *three stages*—a period of increase,

a period of acme, and a period of decrease. The stage of acme lasts longer than the other stages, and the increase is longer than the decrease. The length of the acme differs somewhat at different periods in the course of labor.

The total *duration* of the contraction is about thirty seconds at the onset of labor, and it is gradually lengthened to sixty seconds, or more, as the expulsive efforts reach their height. Variations in both the frequency and the length of the contraction, however, are subject to some degree of irregularity.

The Strength of the Uterine Contraction varies in different women. It differs somewhat in the same parturient at different stages in the progress of labor. Frequently it is observed that each alternate contraction is more powerful than the preceding.

The force of the contraction cannot be definitely stated. It has been estimated by different methods, none of which is entirely satisfactory. According to Duncan, the combined power of the uterine and abdominal muscles may attain a maximum of fifty, or even eighty, pounds; according to Schatz it ranges from seventeen to fifty-five pounds. Poppel, Poullet, and Ribemont have reached conclusions nearly similar to those of Schatz. The estimates of Duncan, Poppel, and Ribemont are based on the force required to rupture the membranes. Schatz measured the downward pressure exerted during a labor pain by means of a species of manometer, but the latter method determines only the force with which the head moves, while the propelling power obviously must equal the sum of the motion and the resistance. Unfortunately, the tocometric methods thus far employed are not wholly reliable. Though we have no means of knowing the precise value of a labor pain, it probably never exceeds and seldom attains the maximum limit above stated.

Changes in the Shape and Position of the Uterus.—During a contraction, according to Fehling, the longitudinal and transverse diameters of the uterus are increased, while its antero-posterior diameter is diminished. The fundus is held forward against the abdominal wall, and the entire organ is forced downward. The long axis of the uterus is brought approximately in line with that of the pelvic inlet. The capacity of the upper or contractile segment is diminished, that of the lower or passive segment is correspondingly increased. The antero-posterior flattening of the uterus becomes more pronounced as the fœtus begins to be expelled. The fœtal ovoid at the same time becomes more elongated. The peritoneal covering adapts itself to the changing shape and size of the uterus, by reason of its elasticity. The muscular structures of all the uterine ligaments doubtless contract simultaneously with those of the organ itself, and to some extent they assist in the expulsion of its contents as well as in fixing the uterus. This is especially true of the round ligaments which act to draw the fundus strongly forward.

(*b*) **The Action of the Abdominal Muscles.** The uterine contractions alone are concerned in the dilation of the lower segment of the uterus which takes place in preparation for the expulsion of the fœtus. Dilation complete, the action of the uterus is reinforced by that of the abdominal walls. At the height of the uterine contraction the woman holds her breath, the diaphragm is fixed, and the intra-abdominal pressure is increased by the contractile power of the abdominal muscles. This adds very greatly to the expelling force, compressing the active portion of the

uterus on all sides. The extruding force of the uterine contraction is supplemented by the general intra-abdominal pressure, and the contents of the organ are impelled in the direction of least resistance, downward through the expanded cervix.

Yet, important as it usually is, the action of the abdominal muscles is not in all cases an essential factor in labor. It is well known that the uterus may expel its contents unaided by the accessory powers. This is exemplified in paraplegic women and in spontaneous deliveries under anæsthesia.

Ordinarily the contractions of the abdominal muscles are under control of the will. Toward the close of the second stage, owing to the reflex effect of painful distension of the birth-canal they become more or less involuntary in character.

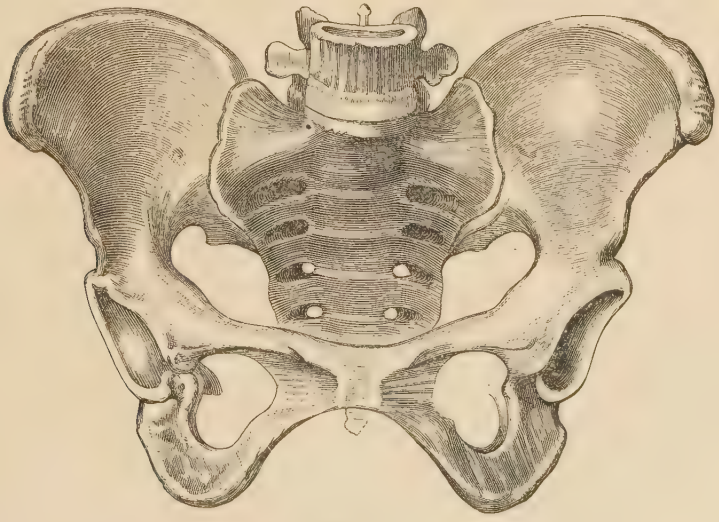
(*c*) **The Action of the Pelvic Floor.** The resistance of the pelvic floor acts in some degree as an obstacle to the progress of the birth until the head is on the eve of expulsion. From this time the tonicity of the levator ani muscles helps to impel the head forward in the direction of the outlet of the soft parts. The same force, too, aids in the expulsion from the vagina of the after-coming pole of the fœtus and in the extrusion of the placenta.

II. The Passages.

Obstetric Anatomy of the Bony Pelvis.

The pelvis is the strong bony basin which forms the most important part of the birth-canal. (Fig. 145.) The term is derived from the Greek word πελις, a bowl. The pelvic canal is irregularly funnel-

FIG. 145.



The female pelvis.

shaped and somewhat flattened from before backward, its larger end looking upward and forward, its smaller downward and backward, in the erect position of the woman. In it are contained the essential organs

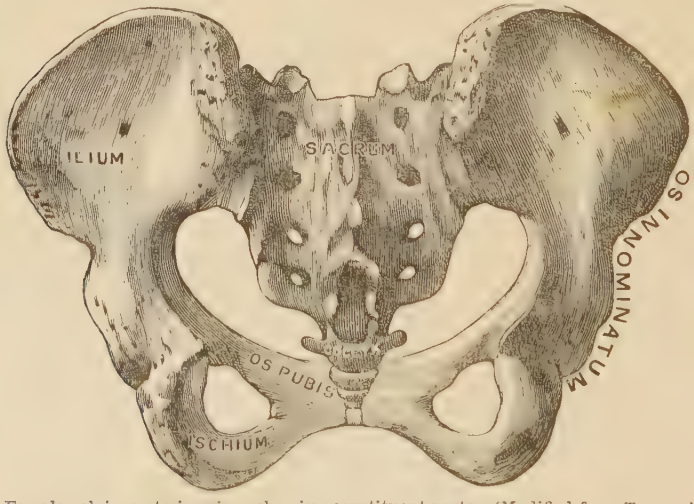
of generation, and through it the child is expelled in the course of labor. Upon its relation to the size and shape of the fœtal mass depend the more important mechanical phenomena of childbirth. An intimate knowledge of the pelvis, as related to the mechanism of labor, affords the "key to the obstetric art."

The Constituent Parts of the Pelvis are: the sacrum, the coccyx, and the two ossa innominata. With the exception of the coccyx, each of these bones, though made up of separate segments in infancy, is practically one in the child-bearing woman.

The Pelvic Joints. Of obstetric importance are the pelvic articulations. They are the sacro-iliac joints, the sacro-coccygeal joint, and the symphysis pubis.

The Sacro-iliac Joints. In these joints each articular surface is invested with a thin plate of cartilage. Small interspaces containing a fluid resembling synovia are usually observed between the cartilages, especially in women; rarely these spaces are wholly absent, and even when they exist a synovial membrane cannot always be demonstrated. In a considerable proportion of cases a true synovial cavity is present and the joint is arthrodial in variety. (Browning.)

Fig. 146.



Female pelvis, posterior view, showing constituent parts. (Modified from Testut.)

The ligaments are the anterior sacro-iliac, the posterior sacro-iliac, and the interosseous ligament.

The *anterior sacro-iliac ligament* is made up of numerous thin and comparatively weak ligamentous bands.

The *posterior sacro-iliac ligament* is of great strength and importance. It consists chiefly of three fasciculi: the two superior run in a nearly horizontal direction from bone to bone; the inferior extends obliquely downward and inward from the posterior superior spine of the ilium to the third and fourth pieces of the sacrum. The latter is the *oblique sacro-iliac ligament.*

The *interosseous ligament* consists of separate bands of fibrous tissue extending between the articular surfaces. This is not always present.

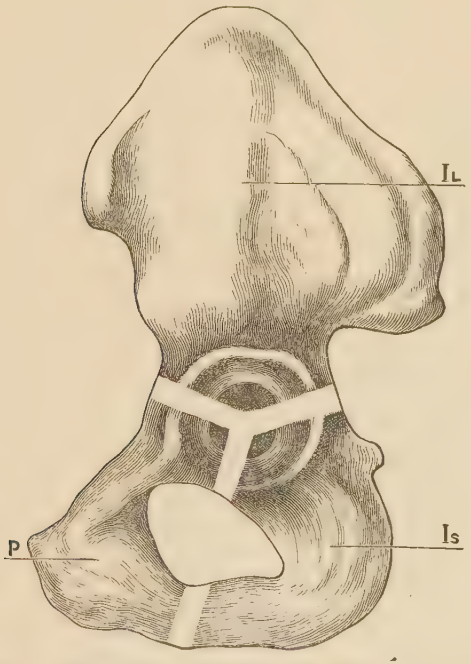
The Sacro-coccygeal Joint. This joint has an interosseous fibro-cartilage which permits recession of the coccyx. Its ligaments are four, one at each aspect of the joint. The articulations of the coccygeal segments usually retain some degree of mobility upon one another during the child-bearing period.

The Symphysis Pubis. The articular surfaces of the pubic bones are united by a disk of fibrous tissue and fibro-cartilage. This interpubic disk is slightly wedge-shaped, being thicker at its anterior than its posterior margin, and thicker at the upper than the lower end of the joint. A small cavity is frequently present in the interosseous disk; it is produced by absorption of the fibro-cartilage, and is never synovial in character. (Browning.) It is oftenest observed in the female.

There are four pubic ligaments, one on each aspect of the joint.

The *anterior pubic ligament* consists of two sets of superficial fibres,

Fig. 147.



Os innominatum before fusion of its three constituent parts. (Ribemont-Dessaignes and Lepage.)
Il. Ilium. Is. Ischium. P. Pubis.

each running obliquely downward across the joint from one pubic bone to the other, and of a deep layer which stretches directly across the symphysis. The fibres of the latter are blended with the subjacent fibro-cartilage.

The *posterior pubic ligament* is essentially a layer of thickened periosteum which passes from the posterior surface of one pubic bone to that of its companion.

The *superior pubic ligament* is a thin bundle of fibres which connects the upper aspects of the bones.

The *inferior pubic ligament*, the ligamentum arcuatum, is a stout, strong, fibrous bundle arching across from the inferior margin of one descending pubic ramus to the other. It blends at the median line with the interpubic disk.

Mobility of the Pelvic Joints. A barely perceptible mobility of the pubic bones upon each other is generally present in the last weeks of gestation. Experience in symphyseotomy has shown that the sacro-iliac articulations are sufficiently movable to permit a separation of the pubic bones to the extent of 5 to 7.5 cm., 2 to 3 inches, after section of the symphysis, without injury to the anterior ligaments The sacrum, too, is capable of rotation in some degree on a transverse axis drawn through its base a little below the level of the promontory. Not only is there a hinge-like motion at the sacro-coccygeal joint, but contiguous segments of the coccyx, as already stated, have some degree of mobility upon each other. Owing to the swelling of the interarticular structures which obtains in all the pelvic articulations toward the close of pregnancy some expansion of the pelvic planes is possible during labor under the wedge-like action of the fœtal head.

The False and the True Pelvis. The bony pelvis presents two divisions —the *false* and the *true* pelvis, or the *greater* and the *lesser* pelvis. The dividing plane cuts the upper anterior margin of the sacrum, the upper end of the symphysis pubis, and the ilio-pectineal line on either side. The part above this plane is the false, that below the true, pelvis.

The false pelvis, together with the vertebral column and the abdominal walls, forms a funnel-shaped approach to the true pelvis. The space included is a part of the abdominal cavity.

The true pelvis. It is with the true pelvis that obstetric problems have mainly to deal. Here it is that the principal resistance to the birth is encountered, and here the more important mechanical phenomena of labor are executed. Upon a clear comprehension of the anatomy of this part of the pelvis in its relation to the parturient process the skill of the obstetrician will largely depend.

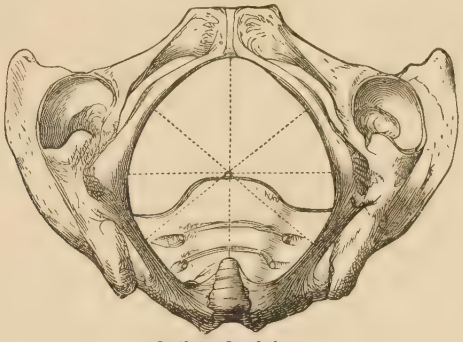
The Brim, Inlet, Superior Strait, Isthmus, or Margin of the True Pelvis. The anatomical inlet is located by the upper margin of the sacrum, the ilio-pectineal lines, and the upper end of the symphysis. Its outline is generally described as approximately heart-shaped. Its contour corresponds nearly to that formed by two ellipses overlapping anteriorly, each of these ellipses representing the engaging sectional plane of the fœtal head. In exceptional cases the brim is an irregular oval or is nearly round in shape.

Obstetric Landmarks at the Brim. Certain anatomical points about the pelvic inlet are frequently referred to as landmarks, both in obstetric writings and in practice. They are: 1. The sacro-vertebral angle, or the promontory of the sacrum. The angle is formed by the inclination of the pelvis, the intervertebral cartilage between the last lumbar and the first sacral vertebræ being wedge-shaped, with its base to the front. (Fig. 150.) 2. The sacro-iliac joints, or rather the points at which they are met by the ilio-pectineal lines. 3. The ilio-pectineal eminences situated on the pubic bones close to the ilio-pubic junctions. 4. The symphysis pubis.

The Outlet or Inferior Strait of the Pelvis. The anatomical outlet of the pelvis is bounded by the summit of the subpubic arch, the ischial

tuberosities, and the tip of the coccyx. The outline is that of a lozenge-shaped figure whose angles have been rounded. (Fig. 148.) Owing to the distensibility of the sciatic ligaments, to the yielding character of the coccyx, and, to some extent, of the sacro-iliac joints, the contour of the outlet becomes ovate at the expulsion of the head. (Fig. 149.)

FIG. 148.



Outlet of pelvis.

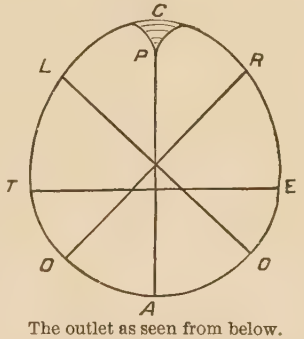
It will presently be seen that the superior and the inferior strait in the obstetric sense are not identical with the anatomical brim and outlet respectively.

Obstetric Landmarks at the Outlet. Anatomical points about the bony outlet which are of special importance as obstetric landmarks are the following: 1. The tip of the coccyx, and of the sacrum. 2. The subpubic arch. 3. The ischial tuberosities. 4. The ischial spines. 4. The obturator foramina.

Sacro-sciatic Ligaments. The greater and the lesser sacro-sciatic ligaments contribute to the formation of the more resistant portion of the parturient canal, which is mainly formed by the bones.

The greater sacro-sciatic ligament arises from the posterior inferior spine of the ilium and from the side of the sacrum and coccyx, narrows and thickens in the middle of its length, broadens again at its anterior attachment, and is inserted into the inner surface of the ischial tuberosity, sending forward a falciform process upon the ischial ramus. (Fig. 150.)

FIG. 149.



The outlet as seen from below. *C.* Under surface of the coccyx. *A P.* The antero-posterior, or pubo-coccygeal diameter. *T E.* Transverse diameter. *R O* and *L O.* Right and left oblique diameters.

The lesser sacro-sciatic ligament takes its origin from the side of the sacrum and of the coccyx, and passing in front of the greater is inserted into the spine of the ischium. (Fig. 150.)

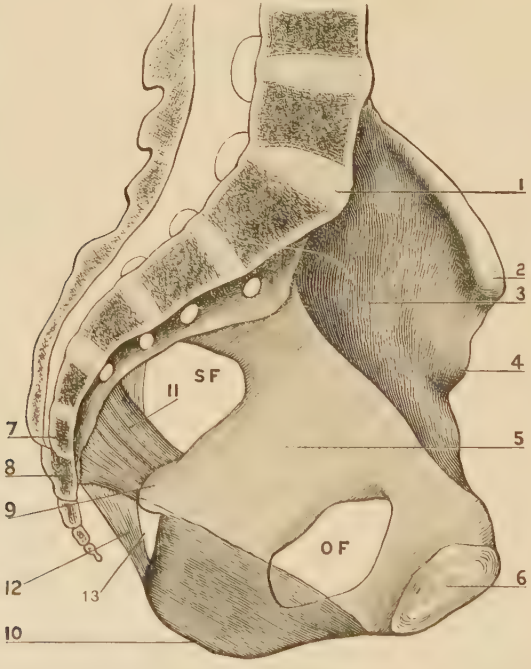
The open spaces between the greater and the lesser sciatic notches and the ligaments are respectively the greater and the lesser sciatic foramina.

The Cavity of the True Pelvis is bounded posteriorly in the main by the sacrum and the coccyx, anteriorly by the pubic bones and their rami, laterally by the lower portions of the ilia and the bodies, tuberosities,

spines, and rami of the ischial bones. It is irregularly cylindrical in shape. The posterior wall is smooth, and is concave from above downward, somewhat so from side to side; its depth, measured on the curve of the sacrum and coccyx, is 11.5 to 12.5 cm., $4\frac{1}{2}$ to 5 inches.

The anterior wall is smooth and concave from side to side; at the symphysis its depth is 4 cm., $1\frac{5}{8}$ inch. The lateral walls corresponding to the broad smooth surfaces of the ischial bones are 9 cm., in depth, $3\frac{1}{2}$ inches. It will be noted that in the passage of the head through the pelvis its posterior pole traverses a much greater distance than does the anterior before it escapes from the bony canal. As will be seen later, the difference in the extent of the posterior and the anterior walls in the soft parts which make up the lower portion of the birth-canal is even greater than in the osseous portion of the parturient tract.

FIG. 150.



Interior surface of left half of pelvis. (Modified from FARABEUF and VARNIER.)

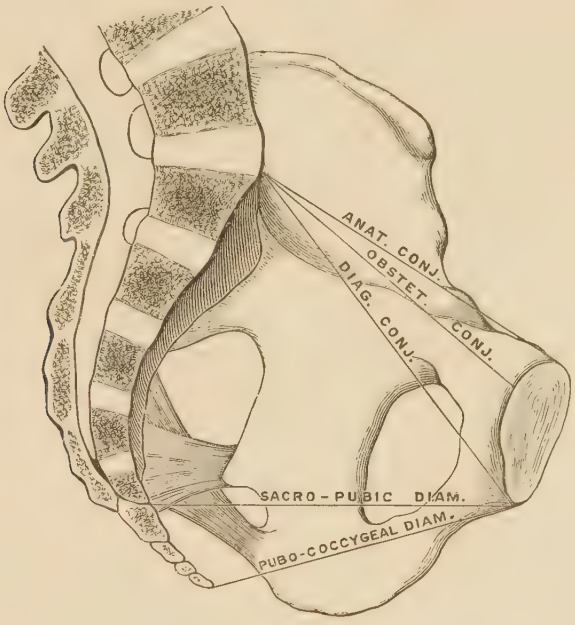
1. Promontory of sacrum. 2. Anterior superior iliac spine. 3. Iliac fossa. 4. Anterior inferior iliac spine. 5. Lateral surface of pelvic cavity. 6. Symphysis pubis. 7. Tip of sacrum. 8. First piece of coccyx. 9. Spine of ischium. 10. Ischium. 11. Lesser sacro-sciatic ligament. 12. Greater sacro-sciatic ligament. 13. Lesser sacro-sciatic foramen SF. Greater sacro-sciatic foramen. OF. Obturator foramen.

Obstetric Planes of the Pelvis. The short curved canal, bounded by the bony walls just described, varies somewhat in shape and in size at different parts of its course. These variations are best understood with the aid of a series of planes drawn transversely through the pelvic cavity at different levels. Three are of special obstetric importance. These are the plane of the brim, the plane of the outlet, and the middle plane.

By the dimensions of these planes the presence or absence of deformity in the canal may usually be determined.

Plane of the Pelvic Brim. The obstetric inlet is the space available for the passage of the head at the superior strait. It is not strictly coincident with the anatomical brim. The latter is the entrance of the lesser pelvis, the former the level of least expansion at the upper portion of the pelvic canal. The plane of the obstetric inlet is located by the summit of the sacral promontory, the ilio-pectineal line, and the posterior surface of the symphysis at a point about 1 cm., $\frac{2}{5}$ of an inch, below its upper margin. (Fig. 151.)

Fig. 151.



The diameters of the pelvis. Shows also location of anatomical and obstetric inlet and outlet. (Farabeuf.)

Plane of the Pelvic Outlet. The structures which bound the anatomical outlet of the pelvis posteriorly are not wholly fixed, but they yield somewhat during labor under pressure of the advancing head. The plane of greatest bony resistance at the inferior strait, therefore, is not that of the anatomical outlet, but a plane somewhat above it. The latter is the inferior strait from the obstetric stand-point. For the obstetrician the plane of the pelvic outlet is one defined by the tip of the sacrum, the ischial tuberosities, and the posterior surface of the pubic symphysis at a point immediately above its lower margin. At the expulsion of the head from the bony outlet, owing to the yielding character of the sciatic ligaments, the shape of this plane becomes ovate, with its greatest expansion directed posteriorly.

The Middle Plane. This plane cuts the upper end of the third piece of the sacrum, the middle of the symphysis pubis, and points

opposite the centres of the acetabular cavities. The latter plane is somewhat larger, the plane of the inferior strait a little smaller than that of the pelvic brim.

Inclination of the Pelvis. The plane of the pelvic brim forms an angle with the horizon of from 50 to 60 degrees, according to the posture of the body. The upper margin of the symphysis pubis in the erect posi-

Fig. 152.

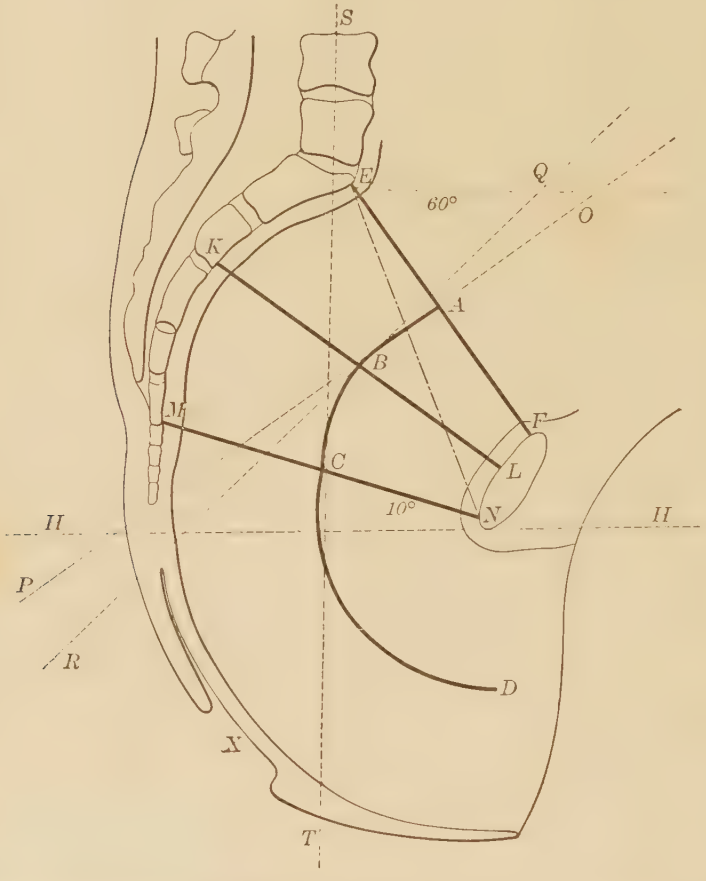


Diagram showing axis and planes of pelvis.

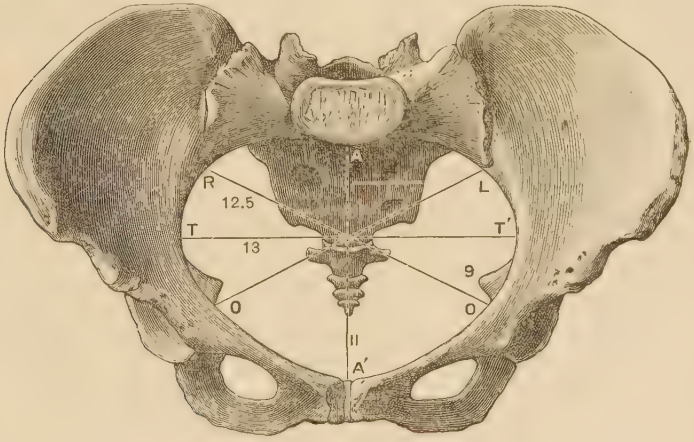
A B C D. Axis of entire parturient canal. *N.* Anus as distended at acme of expulsion. *E F.* Plane of brim. *K L.* Mid-plane of cavity. *M N.* Plane of outlet. *O P.* Axis of brim. *Q R.* Axis of mid-plane. *S T.* Axis of outlet. *H H.* Horizon. *E N.* Diagonal conjugate diameter.

tion of the woman is about 9 cm., 3½ inches, below the level of the promontory. The coccyx is 2 cm. above the level of the subpubic arch, the pubo-coccygeal line making an angle of 11 degrees with the horizon. The direction of the pelvic canal at the inlet turns sharply backward from the body axis. Yet it must be remembered that the inclination of the pelvis is subject to considerable variation in different postures of the body.

The Pelvic Diameters and Measurements.

The varying size and shape of the bony canal at different levels are indicated by the varying dimensions of the horizontal planes of the pelvis. These dimensions are measured on each plane in four directions: the antero-posterior, the transverse, and the two oblique. The several diameters of these planes taken together are spoken of as the internal diameters of the pelvis.

FIG. 153.



Obstetric diameters of the pelvic brim.

A A'. Conjugate diameter. T T'. Transverse diameter. L O. Left oblique diameter. R O. Right oblique diameter.

It should be observed that the measurements given below represent the typical average dimensions of the normal pelvis. Individual pelves may present slight deviations from these measurements within normal limits.

INTERNAL DIAMETERS OF THE STATIC OR DRIED PELVIS.

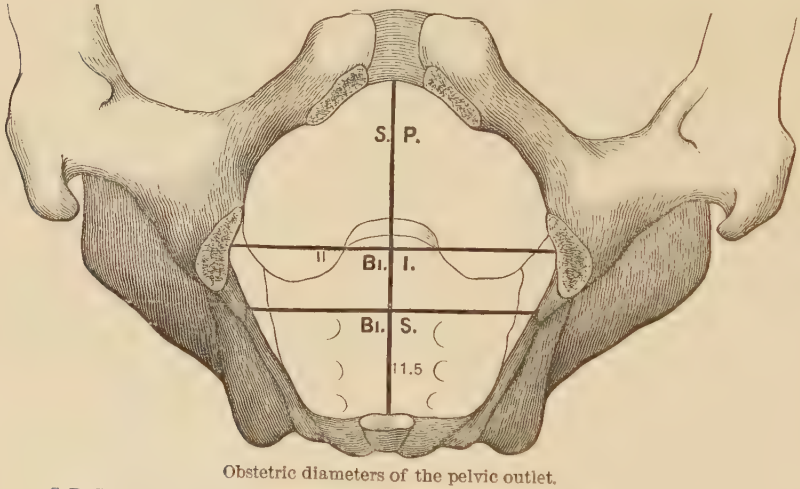
At the Brim. THE ANTERO-POSTERIOR DIAMETER at the brim, in the obstetric sense, is the least distance between the sacral promontory and the pubic symphysis. It represents the available interval between the two surfaces for the passage of the head. It extends from the middle of the sacral promontory to the nearest point on the posterior surface of the symphysis, a point about two-fifths of an inch below its upper margin. It is termed the *conjugate*, or the *true conjugate*, and its value is 11 cm., $4\frac{5}{16}$ inches. (Fig. 153.) The anatomical conjugate extends from the promontory to the upper margin of the symphysis pubis and is about $\frac{1}{2}$ cm. longer than the obstetric conjugate.

THE TRANSVERSE DIAMETER is the greatest distance between the ilio-pectineal lines, and measures 13 cm., $5\frac{1}{8}$ inches. The greatest transverse diameter of the pelvic brim, however, lies too near the promontory to be available for the passage of any of the conventional diameters of the

fœtal head. In a typical relation of head to pelvis, therefore, the head never passes in transverse position. (Fig. 153.)

The Oblique Diameters extend, one from the right, the other from the left sacro-iliac joint at its intersection with the ilio-pectineal line, to the opposite ilio-pectineal eminence. The right oblique springs from the right, the left oblique from the left sacro-iliac articulation. Their values are each about 12.5 cm., 5 inches. (Fig. 154.) The right oblique diameter is slightly longer than the left. It should be noted that by French writers this nomenclature of the oblique diameters is reversed, the left oblique being that which ends at the left and the right oblique that which ends at the right anterior aspect of the pelvic brim.

Fig. 154.



Obstetric diameters of the pelvic outlet.

S. P. Sacro-pubic diameter. Bi. I. Bisischial diameter. Bi. S. Bisciatic diameter.

At the Middle Plane. The Antero-posterior Diameter is the distance from the upper margin of the third piece of the sacrum to the posterior surface of the symphysis pubis at the middle point of its depth, and is 12.75 cm., $5\frac{1}{16}$ inches.

The Transverse Diameter is the greatest transverse width of the pelvis at this plane, and measures 12.5 cm., $4\frac{15}{16}$ inches.

The Oblique Diameters are not measured from fixed points, and are, therefore, valueless for obstetric purposes.

At the Outlet. The Antero-posterior Diameter of the obstetric outlet is a line drawn from the tip of the sacrum to a point just above the summit of the subpubic arch. Its value is 11.5 cm., $4\frac{1}{2}$ inches. The antero-posterior diameter of the anatomical outlet extends from the tip of the coccyx to the summit of the subpubic arch, and measures 9.5 cm., $3\frac{3}{4}$ inches.

The Greatest Transverse Diameter is the bisichial line, and is 11 cm., $4\frac{5}{16}$ inches. It is measured from the inner surface of the ischial tuberosities at the middle of their posterior borders, and corresponds in the living pelvis to a line running transversely through the anterior margin of the anal orifice.

The Oblique Diameters at the outlet are of little practical importance, since their posterior extremities do not rest on fixed points. (Fig. 154.)

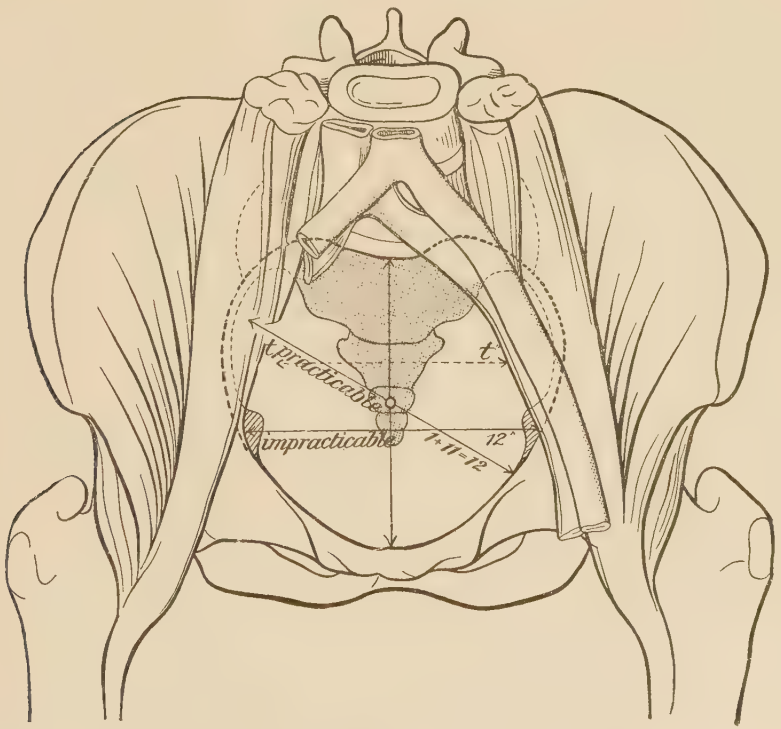
Shape of the Pelvic Canal. It will be seen by comparing the dimensions of the different planes that the pelvic canal is somewhat more roomy at the middle plane and is smaller at the outlet than at the inlet.

Measurements of the Dynamic Pelvis.

Internal Measurements. The dimensions thus far stated relate to the anatomical or dried pelvis. In the pelvis of the living woman—the *dynamic pelvis*—the measurements are more or less modified by the presence of the soft structures which line the bony canal. The internal diameters are all diminished from an eighth to a quarter of an inch by the thickness of the soft parts.

At the brim, owing to the encroachment of the ilio-psoas muscles upon the pelvic space, the transverse diameter is reduced still more, so that, while in the anatomical pelvis the transverse is the longest dimension at the inlet, the oblique is greatest in the obstetric patient. (Fig. 155.)

Fig. 155.



Diameters of the pelvic inlet as affected by the principal soft parts. The oblique is the longest practicable diameter in the dynamic pelvis. (Farabeuf.)

External Measurements. The external bear a fairly constant relation to the internal dimensions of the pelvis. External measurements are,

therefore, useful to the obstetrician in determining the probable capacity of the pelvic canal. They are especially valuable for the reason that they may be more readily and more accurately determined in the living subject than can the internal diameters. The more important external measurements are: The External Conjugate Diameter, or Diameter of Baudelocque, the Interspinal, and the Intercristal Diameters.

The External Conjugate Diameter is the distance from the fossa immediately below the spine of the last lumbar vertebra to a point on the anterior surface of the pubes, two-fifths of an inch below the upper margin of the symphysis, and its value is 21 cm., about $8\frac{1}{4}$ inches.

The external conjugate is obviously subject to considerable variation, dependent on the thickness of the bony structures and of the overlying soft parts. The difference between the external and the internal conjugate ranges from 7 to 12.7 cm., $2\frac{3}{4}$ to 5 inches, the average being 9 cm., $3\frac{1}{2}$ inches.

The Interspinal Diameter is the distance between the outer aspects of the anterior spines of the ilium, measured from the outer margin of the insertion of the sartorii, 26 cm., $10\frac{1}{4}$ inches.

The Intercristal Diameter is the greatest distance between the outer borders of the iliac crests, 29 cm., about $11\frac{1}{2}$ inches.

External Oblique Diameters. In addition to the foregoing the *external oblique diameters* may be measured to test the symmetry of the pelvis; each represents the distance from the posterior superior spine of one to the anterior superior spine of the opposite iliac bone, and in the normal pelvis they are equal.

The Bisischial Diameter, 11 cm., about $4\frac{1}{4}$ inches, since it may be measured externally as well as internally, may be enumerated with the external diameters.

The Bitrochanteric Diameter, which is the distance from one trochanter major to its companion, is usually included with the pelvic measurements. Its value is 32 cm., about $12\frac{1}{2}$ inches.

The following tabular statement of the pelvic measurements will be found convenient for reference:

Summary of Internal Measurements of the Dried Pelvis.

	Antero-posterior diameters.	*Oblique diameters.*	*Transverse diameters.*
Brim	11 cm.	12.5 cm.	13 cm.
Mid-plane	12.75 cm.	. . . . .	12.5 cm.
Outlet	11.5 cm.	. . . . .	11 cm.

Circumference of the brim, 40 cm., 16 inches; of the outlet, 33 cm., 13 inches.

The internal diameters of the dried pelvis, as stated in the following table, are sufficiently exact for practical purposes, and they have the advantage of being easily remembered:

Approximate Internal Measurements of the Pelvis.

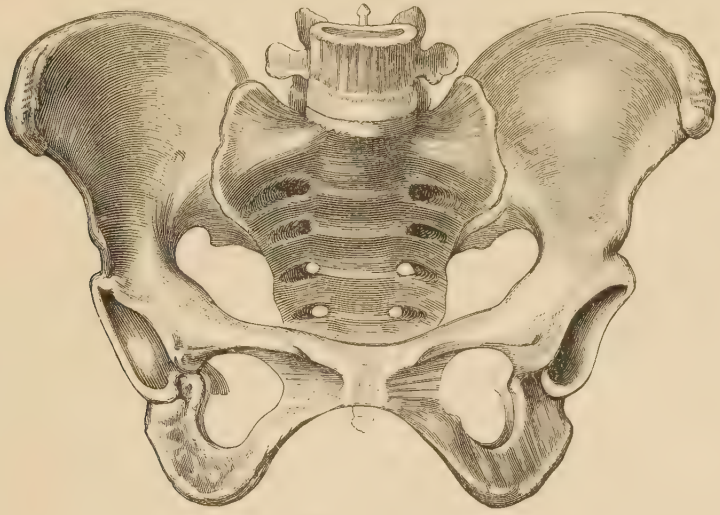
	Antero-posterior.	*Oblique.*	*Transverse.*
Brim	4 inches.	$4\frac{1}{2}$ inches.	5 inches.
Mid-plane	$4\frac{1}{2}$ "	$4\frac{1}{2}$ "	$4\frac{1}{2}$ "
Outlet	5 "	$4\frac{1}{2}$ "	4 "

Summary of External Measurements of the Dynamic Pelvis.

External conjugate diameter	21 cm.
Interspinal diameter	26 "
Intercristal "	29 "
Bisischial "	11 "
Bitrochanteric "	32 "

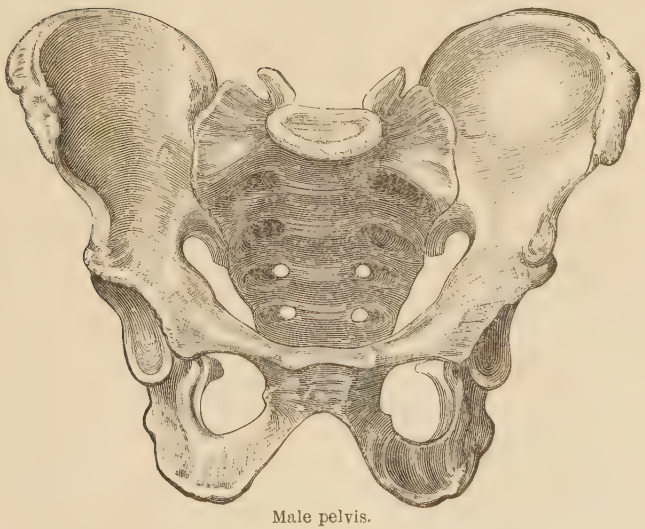
The *average external circumference* of the pelvis measured over the symphysis, just below the iliac crests, and across the middle of the sacrum is one yard.

FIG. 156.



Female pelvis.

FIG. 157.



Male pelvis.

It must be understood that the external measurements, while of considerable value, do not afford entirely reliable data for estimating the capacity of the birth canal. Yet of the external conjugate, the most useful of the external measurements for determining the pelvic space at the brim, it may safely be stated that when it is below 16 cm., the internal conjugate is surely contracted, when above 20.5 cm., the latter diameter

is almost surely ample. When the diameter of Baudelocque falls between these limits, the corresponding internal diameter may or may not be normal. The question must then be decided by internal measurements.

Differences Between the Male and the Female Pelvis.

Until the age of puberty the pelves of the opposite sexes according to Schroeder and other authorities, present no striking differences of structure. Later observations have not sustained this view. Recent researches seem to show that differentiation becomes apparent during intrauterine development soon after midpregnancy. In the mature woman the distinguishing marks of the pelvis as compared with that of the male are chiefly these:

As a whole, the bones are lighter and more slender. The false pelvis is somewhat smaller and the true pelvis larger in all diameters and of shallower depth.

The brim is less triangular and its capacity greater, the sacro-vertebral angle is more prominent, and the pubic spines are farther apart.

The cavity is less funnel-shaped, and all its horizontal diameters are greater. The sacrum is shorter and broader, and it presents a more nearly uniform antero-posterior curvature.

The outlet is larger; the width of the subpubic arch is greater, 90 to 100 degrees, the angle in the male measuring from 70 to 80 degrees. The depth of the symphysis pubis is less.

Differences Dependent on Racial Characteristics.

Marked differences in the form and size of the pelvis obtain in different races. Yet these variations of type are largely due, as Spiegelberg has intimated, to conditions of nutrition and activity.

Pelvic deformities are most frequent in the inferior races. A larger proportion of dwarfed pelves is observed in races of a low order of physical development. A common deviation from the normal Caucasian type consists in a relative elongation of the antero-posterior dimensions of the pelvis as compared with the transverse. Thus the pelvis of the Australian is nearly circular in horizontal outline, and in Bush women the antero-posterior equals the transverse diameter. The pelvis of the Laplander is small.

Obstetric Anatomy of the Soft Parts of the Parturient Tract.

The Uterus forms a part of the parturient canal. Yet, as will be seen in connection with the physiology of labor, the organ resolves itself into two segments which sustain very different relations to the parturient process, an upper, contractile, and a lower, passive, segment. The upper segment is of interest chiefly as the principal source of the propelling power, the lower, the seat of resistance at the beginning of labor, belongs more properly to the passages than does the contractile portion of the organ.

The Soft Parts of the Pelvis which concern the obstetrician are chiefly the muscles which line the bony excavation and the structures which

compose the pelvic floor. The former, as already stated, reduce slightly the capacity of the bony cavity; the latter supplement the osseous portion of the parturient tract. Lying immediately above the lateral margins of the brim, the iliacus and psoas muscles diminish the transverse width of the bony inlet to the extent of about a quarter of an inch on each side. The external iliac vessels run along the inner borders of these muscles. The main trunk of the lumbar plexus follows the course of the psoas, and the crural nerve runs between the psoas and the iliacus muscles.

The median portion of both the anterior and the posterior pelvic walls is devoid of muscular coverings. On either side of the median section lie the pyriformis posteriorly and the obturator internus anteriorly and laterally. These muscles are thin and are so located as scarcely to lessen appreciably the capacity of the pelvis.

The Pyriformis is a fan-shaped muscle arising by digitations from the anterior aspects of the second, third, and fourth sacral vertebræ, from the upper margin of the greater sciatic notch, and from the anterior surface of the greater sacro-sciatic ligament; it passes out of the pelvis by the greater sacro-sciatic foramen to its insertion in the femur. The nerves of the sacral plexus lie in front of this muscle.

The Obturator Internus Muscle arises from the inner surface of the obturator membrane, from the fibrous arch which completes the canal for the obturator vessels and nerves, and from the inner surface of the innominate bone anteriorly between the obturator foramen and the margin of the ischio-pubic ramus, and laterally over an area extending backward to the sciatic notch, upward to the brim, and downward to the outlet; a few fibres arise from the obturator fascia which covers the internal surface of the muscle; its fibres converge and pass out through the lesser sacro-sciatic foramen to be inserted into the great trochanter.

The Bladder in the front portion of the pelvic cavity does not when empty appreciably diminish its capacity. Moreover, during the beginning stage of labor, as will be explained later, the greater portion of this viscus is drawn up above the inlet of the pelvis.

The Rectum at the brim lies in front of the left sacro-iliac joint; it thence runs inward to descend in the median line along the anterior surface of the sacrum and the coccyx. It encroaches but little on the pelvic space except when distended, yet the left oblique diameter at the brim, which in the dried pelvis is shorter than the right, is rendered still more so by the presence of the rectum, especially when the latter is filled. The greater frequency with which the head enters the pelvis in the right oblique diameter than in the left is explained by these facts.

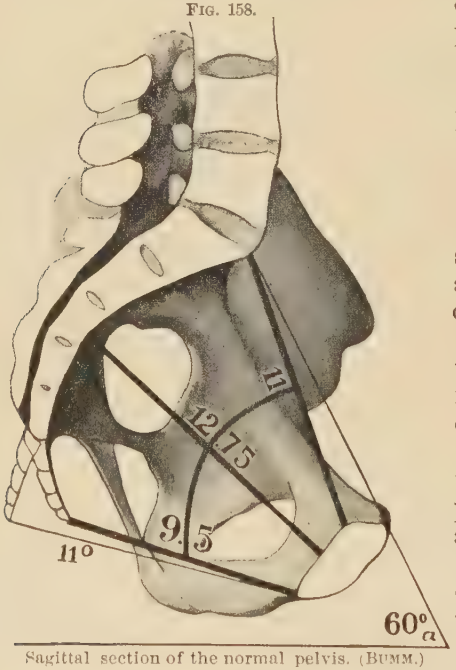
The Pelvic Floor comprises the soft structures which close the outlet of the bony pelvis and give support to the pelvic and abdominal contents. Its upper limit is the peritoneum except where that structure is lifted off to be reflected over the pelvic viscera. Its lower surface is the skin. At its median portion it is obliquely traversed by three muscular slits, the urethra, the vagina, and the rectum, all approximately parallel with the pelvic brim, save that the lower end of the rectum turns backward nearly at a right angle with the vagina.

The posterior vaginal wall and the soft structures behind it constitute the *sacral segment;* the anterior wall of the vagina and the soft parts in front of it compose the pubic segment of the pelvic floor (Hart).

In labor the pubic segment of the floor is drawn upward and the sacral segment is distended and thrust downward as the fœtus descends through the infra-osseous portion of the parturient canal. The resiliency of the posterior segment of the floor holds the fœtal mass in close relation with the ischio-pubic rami during the completion of the birth, and assists in its final expulsion.

Measurements. In the nullipara the distance from the coccyx to the anus is 4.5 cm., $1\frac{3}{4}$ inch; from the anus to the lower margin of the vulvar orifice, 3.2 cm., $1\frac{1}{4}$ inch; in the parous woman the latter distance is 2.5 cm., 1 inch; in the primigravida at term, 3.8 cm., $1\frac{1}{2}$ inch. The greatest transverse width of the pelvic floor, on the bisischial line, is 11 cm., $4\frac{3}{8}$ inches; the perpendicular thickness at the anus is about 5 cm., 2 inches. In the non-gravid woman the average projection below a line drawn from the tip of the coccyx to the summit of the subpubic arch is about 2.5 cm., 1 inch. The length of the sacral segment during labor at the acme of expulsion—coccyx to lower edge of vulvar orifice—is 15 cm.,6 inches.

Fig. 158.



Sagittal section of the normal pelvis. (Bumm.)

The more important component parts of the pelvic floor are its muscular structures and fascial sheets. On the latter its strength and supporting power mainly depend.

For a detailed description of the anatomy of the pelvic floor the reader is referred to the chapter on The Female Pelvic Organs.

Axis of the Pelvis. It is obvious that an infinite number of pelvic planes may be drawn in addition to the cardinal planes previously described. All, if extended, would meet in front of the pubic joint. The mathematical axis of the pelvic canal is a line which pierces each of these planes perpendicularly at its centre point. Such a line is a line with its concavity forward, and it represents approximately the course which the fœtal head follows in its descent through the pelvis in typical labors. The axis of the inlet prolonged strikes the tip of the coccyx and a point on the abdominal wall near the umbilicus. The axis of the obstetric outlet of the bony pelvis if extended would pass immediately in front of the sacral promontory. The course of the osseous portion of the canal depends upon the longitudinal curvature of the sacrum, and varies accordingly. The plane of the vulvo-vaginal ring at the moment when the fœtal head is expelled is nearly parallel with the long axis of the mother's body. The outlet of the soft parts, therefore, at the acme of expulsion, looks almost directly forward. (Fig. 158.)

III. The Fœtus.

The head, the upper part of the trunk, and the breech of the fœtus each fills the pelvis more or less completely during its passage through it, and each has sufficient rigidity to retain its primal shape in some degree during labor. These parts of the fœtal mass, therefore, all sustain an important relation to the mechanism of labor. The head, however, is much larger in proportion to the trunk in the fœtus than in the adult. As a whole, its diameters are greater than those of the shoulders or the breech and thighs, and are more incompressible. It follows that the principal resistance to the passage of the child through the pelvis is offered by the head. While the body of the fœtus cannot wholly be neglected in the study of the mechanism of labor, it is with the head that obstetric questions are mainly concerned.

Obstetric Anatomy of the Fœtal Head. For the obstetrician the fœtal head present two general divisions: 1, the cranial vault; 2, the cranial base and face. The former, owing to the semi-cartilaginous character and the mobility of its bones, is plastic, a fact of great importance in facilitating the passage of the head through the pelvis; the latter is firm and unyielding, its bony structures being more highly ossified and more firmly united. Protection is thus afforded during birth to the ganglia at the base of the brain.

It is necessary to bear in mind, however, that the plasticity of the fœtal head differs in different infants at term. The degree of ossification and the firmness of union between the cranial bones in the fully developed fœtus are subject to considerable variation, and the hardness of the head is an essential element in the labor.

THE BONES of the cranial vault are the two parietal, the two frontal, the squamous portion of the occipital and those of the two temporal bones. They are united only by the unossified external periosteum and by the dura mater. The presence of membranous interspaces as well as the flexible character of the bones contributes to the plasticity of the cranial vault.

THE SUTURES of the vault are the membranous intervals between two adjacent bones. Those of obstetric importance are the *sagittal* or *inter-parietal*, the *frontal* or *interfrontal*, the *coronal* or *fronto-parietal*, the *lambdoidal* or *occipito*-parietal sutures. (Figs. 159 and 160.)

THE FONTANELLES are the greater spaces formed by the widening out of the sutures between the angles of three or four adjacent bones.

The anterior fontanelle, or bregma, is situated at the junction of the sagittal, the coronal, and the frontal sutures. It is identified in the vaginal examination during labor by the following characters. It is kite-shaped, or quadrangular, with its most acute angle forward. Its average diameter is one inch. Its size, however, varies in different fœtal heads, and is much diminished by overlapping of the bones when the head is firmly wedged in the pelvis. Four lines of sutures run into it.

The posterior fontanelle is formed at the junction of the sagittal and the lambdoidal sutures. It presents to the examining finger the following distinguishing marks: It is small, usually a mere depression, barely perceptible to the finger-tip. Three lines of suture run into it. Behind it is the squamous or triangular portion of the occipital bone, which is

movable upon the basilar portion by a hinge-like joint of fibrous tissue. In exceptional instances in well-ossified heads this fontanelle is absent. Frequently during labor the interspace is obliterated by the crowding together or overlapping of the cranial bones.

FIG. 159.

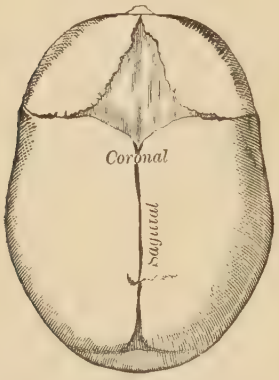
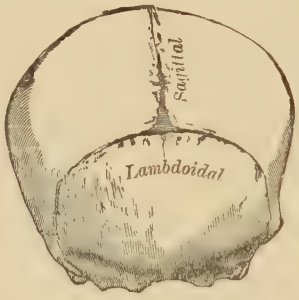


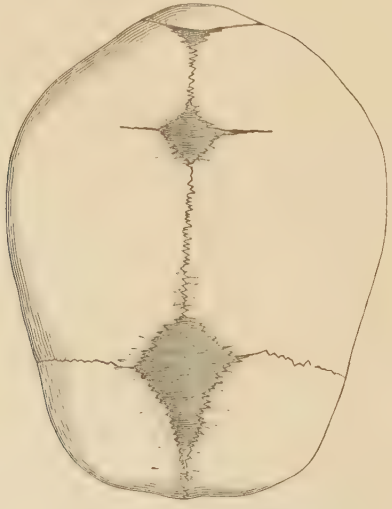
FIG. 160.



Anterior and posterior fontanelles, sagittal, lambdoidal, coronal, and frontal sutures.

Temporal Fontanelles. A fontanelle exists on either side of the head at the junction of the temporal with the parietal and occipital bones. They are of little obstetric interest, except for the fact that in rare cases one of them may fall within reach of the examining finger and be mistaken for the occipital fontanelle.

FIG. 161.



Fœtal head seen from above, showing false fontanelle between the anterior and the posterior fontanelle. (After RIBEMONT-DESSAIGNES and LEPAGE.)

False Fontanelles, due to failure of ossification, are exceptionally observed either in the body of the bone or in the course of a suture. (Fig. 161.)

Wormian Bones. Rarely there are small, supernumerary bones in the interparietal space. They are the result of irregular ossification, and are known as Wormian bones.

In the examination of the head for diagnosis of position, the practitioner must have in mind the possibility of being misled by these anomalies.

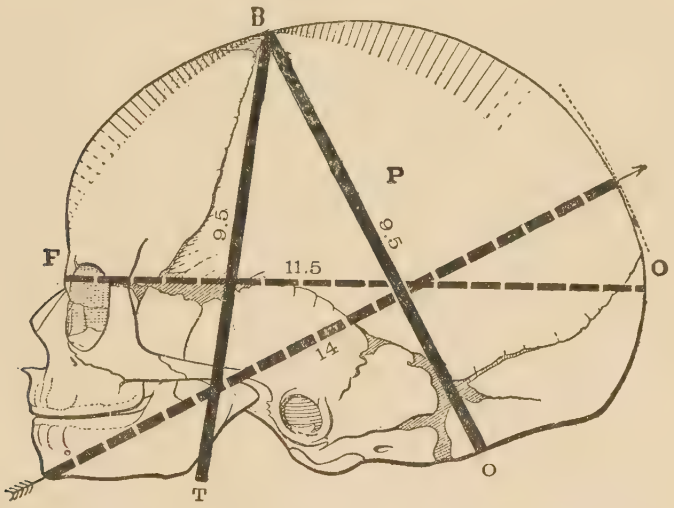
PROTUBERANCES. The cranial bones present five protuberances which are of interest as obstetric landmarks. They are the occipital, the two parietal, and the two frontal. The *occipital protuberance* is situated 2.5 cm., 1 inch, or more behind the posterior fontanelle. The *parietal protuberance* or boss is the bony eminence at the centre of each parietal bone. The *frontal protuberance* is the eminence at the centre of each frontal bone.

THE VERTEX is that portion of the head between the anterior and the posterior fontanelles and extending laterally to the parietal eminences.

THE OCCIPUT is the part of the head behind the posterior fontanelle.

THE SINCIPUT is that portion of the cranial vault in front of the bregma.

FIG. 162.



The diameters of the fœtal head. (Modified from FARABEUF and VARNIER.)

O F. Occipito-frontal. O B. Suboccipito-bregmatic. T B. Trachelo-bregmatic. The maximum diameter, occipito-mental, is indicated by the long dotted arrow. Measurements are in centimetres.

Measurements of the Fœtal Head. Obviously the obstetrician must take into account the shape and dimensions of the fœtal head, as well as of the pelvis. Not only the size, but the configuration of the cephalic mass is an essential element in the relation of the head to the birth-canal. These elements in the obstetric problem are best understood with the aid of a series of head diameters and circumferences measured in different planes. The diameters of the head commonly made use of are the occipito-frontal, the occipito-mental, the suboccipito-bregmatic, the biparietal, the bitemporal, the bimastoid, the fronto-mental, and the trachelo-bregmatic. (Figs. 162 and 163.)

The *occipito-frontal diameter* is measured from the tip of the occipital protuberance to the root of the nose.

The *occipito-mental* diameter extends from the occipital protuberance to the centre of the lower margin of the chin.

The *suboccipito-bregmatic* diameter extends from the junction of the nucha and the occiput to the centre of the bregma.

The *suboccipito-frontal* extends from the junction of nucha and occiput to the summit of the forehead.

The *biparietal diameter* is measured through the centres of the parietal eminences.

FIG. 163.

Engaging diameters of the flexed head. (After FARABEUF and VARNIER.)
P P. Biparietal diameter, 9 cm. *O B.* Suboccipito-bregmatic diameter, 9.5 cm.

The *bitemporal* is the distance between the lower extremities of the coronal suture.

The *bimastoid* is the distance between the mastoid apophyses.

The *fronto-mental diameter* extends from the summit of the forehead to the centre of the lower margin of the chin.

The *cervico-bregmatic* extends from the junction of neck and chin to the centre of the bregma.

The average values of these diameters are given in the following table:

AVERAGE DIAMETERS OF THE FŒTAL HEAD.

Occipito-frontal diameter	11.5 cm.	4½ inches.
Occipito-mental "	14 "	5½ "
Suboccipito bregmatic diameter	9.5 "	3¾ "
Suboccipito-frontal "	11 "	4⅜ "
Biparietal diameter	9.5 "	3¾ "
Bitemporal "	8 "	3⅛ "
Bimastoid "	7 "	2¾ "
Fronto-mental diameter	9 "	3½ "
Trachelo-bregmatic diameter	9.5 "	3¾ "

APPROXIMATE DIAMETERS OF THE FŒTAL HEAD. For easy memorizing the approximate diameters of the fœtal head may be stated with sufficient accuracy for practical purposes as follows:

Biparietal	9 cm.	3½ inches.
Suboccipito-bregmatic	9 "	3½ "
Fronto-mental	9 "	3½ "
Occipito-frontal	11.5 "	4½ "
Occipito-mental	14 "	5½ "

Planes of the Fœtal Head. Just as the pelvis is studied with the aid of the horizontal planes, so the size and shape of the head in its relation to the birth-canal may more easily be appreciated with the help of cross-sections made through its more important diameters. Most useful for this purpose are the occipito-mental section through the biparietal and the occipito-mental diameters, the occipito-frontal section through the biparietal and the occipito-frontal diameters, the suboccipito-frontal through the bitemporal and the suboccipito-frontal diameters, the suboccipito-bregmatic through the biparietal and the suboccipito-bregmatic diameters. By comparison of these sectional planes it will be seen that the suboccipito-bregmatic plane, which normally is the plane that falls in relation with the different pelvic planes successively as the head descends, is not only the smallest but is nearly circular. It measures, after the head is well moulded to the pelvis, $9\frac{1}{4}$ cm., about $3\frac{5}{8}$ inches, in the biparietal, and but little more in the opposite diameter. Its circumference is about 32 cm., $12\frac{5}{8}$ inches, while the occipito-frontal circumference is 34 cm., $13\frac{3}{8}$ inches, and the occipito-mental 35 cm., $13\frac{3}{4}$ inches. The suboccipito-bregmatic is the plane which engages in complete flexion of the head. Thus it is obvious that the difference between a fully flexed and a partially extended head may make all the difference between an easy and a difficult or impossible delivery.

Circumference of the Fœtal Head. The cross-sections of the head whose circumferences are in most cases the maximum circumferences engaging in the pelvis are the suboccipito-bregmatic and the suboccipito-frontal. The occipito-frontal may be noted, yet normally the latter plane is replaced by a smaller one as the head becomes well flexed. These cross-sections extend through the corresponding diameters respectively. Their circumferences are as follows :

Suboccipito-bregmatic circumference	32	cm.	$12\frac{5}{8}$ inchés
Suboccipito-frontal "	35	"	$13\frac{3}{4}$ "
Occipito-frontal "	34	"	$13\frac{3}{8}$ "

Moulding. Comparing the dimensions of the fœtal head with one another it will be seen that the head during its descent through the pelvis is an irregular cylindrical mass, the long axis of which is 14 cm., $5\frac{1}{2}$ inches, and the transverse 9.5 cm., $3\frac{3}{4}$ inches.

Normally the long axis of the cylinder lies nearly in relation with the axis of the birth-canal; the engaging diameters of the average head, those which lie across the parturient tract, differ little from those of the maternal pelvis. The value of the suboccipito-bregmatic circumference is nearly the same as that of the pelvic outlet.

In most births the cylindrical form of the cephalic mass becomes fully developed during labor, owing to the moulding which takes place from the pressure effects of the birth-canal. The elongation of the cylinder is further increased by the formation upon the presenting part of the caput succedaneum, to be described in another chapter.

The principal diameters of the head are all affected in greater or less degree by the moulding of the head in its passage through the birth-canal. The biparietal is reduced in ordinary labor by about 0.6 cm., $\frac{1}{4}$ inch. The suboccipito-bregmatic and the suboccipito-frontal are correspondingly shortened. The occipito-mental is lengthened. In a word, the engaging diameters are compressed, and there is a corresponding elongation of the diameter which is in relation with the axis of the

parturient tract. The moulding is chiefly the result of overlapping of the cranial bones. It may be noted in passing that the measurements of the head for record, after birth, should be taken after it has resumed its normal shape.

The head undergoes in slight degree a total reduction in volume during its passage through the pelvis, owing to the fact that a portion of the cerebro-spinal fluid and of the contents of the intracranial blood-vessels is forced out of the cranial cavity by compression.

The plasticity of the head is obviously an essential factor in the parturient process. The hardness of the cranial vault is, therefore, always to be taken into account in estimating the prognosis of labor.

The Trunk. The trunk diameters are small, and moreover are so compressible as to render them of relatively little importance in the mechanism of labor. The longest of the trunk diameters is the bisacromial. Its length is 12 cm., $4\frac{3}{4}$ inches; but it is reducible to the extent of at least 2 or 3 cm. The antero-posterior or sterno-dorsal diameter at the level of the shoulders is 8.5 cm., $3\frac{5}{8}$ inches, and is reducible to 8 cm. The average chest measure (circumference) is $12\frac{1}{4}$ inches. The bitrochanteric diameter is 9 cm., $3\frac{1}{2}$ inches. The antero-posterior diameter at the breech, the sacro-pubic, is 5.5 cm., $2\frac{1}{8}$ inches. With the superadded thickness of the thighs flexed upon the abdomen, the latter diameter is nearly doubled.

Length and Weight of the Mature Fœtus. The length of the child at term is usually between 46 and 51 cm., approximately 18 and 20 inches. The average weight is 3175 to 3288 grammes, 7 to $7\frac{1}{4}$ pounds, males weighing more than females, and first, as a rule, less than subsequent births. The birth weight at term may be said to range from 2722 to 5443 grammes, 6 to 11 or 12 pounds. Yet the latter weight is extremely rare and is very seldom exceeded. There is usually a progressive gain in the weight of the children in successive pregnancies of the same mother till the fourth or fifth.

The average weight of 529 new born children in the maternity service at the Long Island College Hospital was seven and one-half pounds, somewhat in excess of the foregoing estimates.

Mobility of the Fœtal Head Upon the Spinal Column. The movements of extension or flexion and of rotation of the head upon the trunk sustain important relations to the mechanism of labor, as will be seen in connection with the discussion of that subject. These movements are favored by the laxity of the joints in the cervical portion of the spinal column. The limit of safe rotation of the head upon the trunk is generally believed to be 90 degrees on either side. Tarnier, however, points out that the rotation may be continued without injury to the spinal cord or to the ligaments till the face looks directly backward. The torsion is not confined to a single point in the spinal column, but is distributed along the upper portion of its length.

Presentation, Position, and Posture of the Fœtus.

Presentation is, in general terms, the relation of the long axis of the fœtal ovoid to the uterine axis. Under this definition we have two varieties of presentation, longitudinal and transverse.

Longitudinal Presentation is that in which the long axis of the

fœtal ovoid corresponds with the axis of the uterus, either the cephalic or the pelvic extremity offering at the brim of the pelvis.

Transverse Presentation is that in which the long axis of the fœtal mass lies across the long axis of the uterus. Except very rarely, however, its direction is not transverse but oblique. In this presentation any part of the fœtus, except the cephalic or the podalic extremity, may offer primarily at the pelvic inlet.

As commonly employed the term presentation refers to the part of the fœtus which presents at the pelvic brim. Thus we have *cephalic* and *breech* as subvarieties of longitudinal presentation; *vertex*, *face*, and *brow* as subvarieties of cephalic presentation; *breech* and *foot* as subvarieties of pelvic presentation; *shoulder*, *arm*, and *hand* as subvarieties of transverse presentation. Since in transverse presentation the shoulder ultimately becomes the presenting part, transverse is also known as shoulder presentation.

The term *presenting* part is used to denote the part of the fœtal ovoid which offers to the examining finger. It is, therefore, synonymous with presentation in the sense last referred to.

The varieties and subvarieties of presentation may be summarized as follows:

Presentations.

1. Longitudinal.
   A. Cephalic. (*a*) Vertex; (*b*) face; (*c*) brow.
   B. Breech. (*a*) Breech; (*b*) knee; (*c*) foot.
2. Transverse.
   (*a*) Shoulder; (*b*) arm; (*c*) hand.

Relative Frequency of the Different Presentations. The vertex presents in about 97 per cent. of all labors at term. Spiegelberg found cephalic presentations in 97 per cent. of the children in 97,871 labors; Lepage in 97.32 per cent. of 3032 primiparæ, and in 97.24 per cent. of 3598 multiparæ, at the Clinique Baudelocque. The breech presents in about 1.6 per cent. of all term labors; transverse presentation occurs in 0.5 per cent. The preponderance of vertex presentation, is due mainly to adaptation of the fœtal ovoid to the shape of the uterus, and in some degree to gravity, the cephalic being the heavier extremity of the fœtus.

Position. Position is the relation of the presenting part to the quadrants of the pelvic brim, the quadrants being those into which the brim is divided by its antero-posterior and its transverse diameters. For each presentation there are four positions. They are named according to the particular quadrant confronted by the presenting part, sometimes from some anatomical point at the brim selected for its prominence.

In vertex, face, and breech presentations the long diameter of the presenting part engages in one of the oblique diameters of the pelvic inlet. In vertex presentation the occiput looks to the right or to the left anterior or to the right or left posterior quadrant. When the occiput confronts the left anterior quadrant, the position is left occipito-anterior; if it faces the right anterior quadrant, the position is right occipito-anterior, and so on. The positions are sometimes spoken of as first, second, third, and fourth, the left occipito-anterior being the first, and the others following in order from left to right around the pelvic

brim. Face positions are named in similar manner according to the direction of the chin—left mento-anterior, etc.; breech positions, according to the direction of the sacrum—left sacro-anterior, etc.; shoulder positions, according to the direction of the scapula—left scapulo-anterior, etc. It may be observed that the method of naming breech positions does not conform fully to the rule above mentioned in that the nomenclature of breech positions is based upon the relation of the sacrum rather than the presenting part to the different quadrants of the brim.

Vertex Positions.

Left occipito-anterior. L. O. A.
Right occipito-anterior. R. O. A.
Right occipito-posterior. R. O. P.
Left occipito-posterior. L. O. P.

The relative frequency of the different vertex positions may be estimated approximately at 70, 10, 17, and 3 per cent respectively.

Face Positions.

Left mento-anterior. L. M. A.
Right mento-anterior. R. M. A.
Right mento-posterior. R. M. P.
Left mento-posterior. L. M. P.

Breech Positions.

Left sacro-anterior. L. S. A.
Right sacro-anterior. R. S. A.
Right sacro-posterior. R. S. P.
Left sacro-posterior. L. S. P.

Transverse or Shoulder Positions.

Left scapulo-anterior. L. Sc. A.
Right scapulo-anterior. R. Sc. A.
Right scapulo-posterior. R. Sc. P.
Left scapulo-posterior. L. Sc. P.

Posture, or the *attitude* of the fœtus, is the relation of the fœtal members to one another. The normal posture of the fœtus during pregnancy and parturition is one of flexion. The head is flexed, the arms are folded on the chest, the legs are flexed upon the thighs, and the thighs upon the abdomen. The back is arched, and the fœtal mass presents an ovoid shape. The fœtal posture is the result partly of the primitive form of the embryo, mainly of the uterine pressure forces. As an element in the labor, posture is most important as relates to the head.

FIG. 164.

Vertex. Left occipito-anterior position. (FARABEUF and VARNIER.)

FIG. 165.

Vertex. Right occipito-anterior position. (FARABEUF and VARNIER.)

FIG. 166.

Vertex. Right occipito-posterior position. (FARABEUF and VARNIER.)

FIG. 167.

Vertex. Left occipito-posterior position. (FARABEUF and VARNIER.)

FIG. 168.

Face. Left mento-anterior position. (FARABEUF and VARNIER.)

FIG. 169.

Face. Right mento-anterior position. (FARABEUF and VARNIER.)

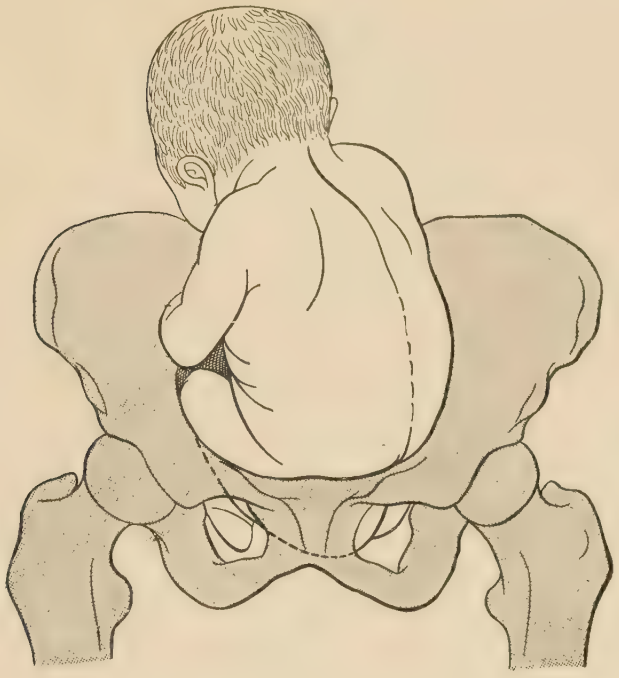
FIG. 170.

Face. Right mento-posterior position. (FARABEUF and VARNIER.)

FIG. 171.

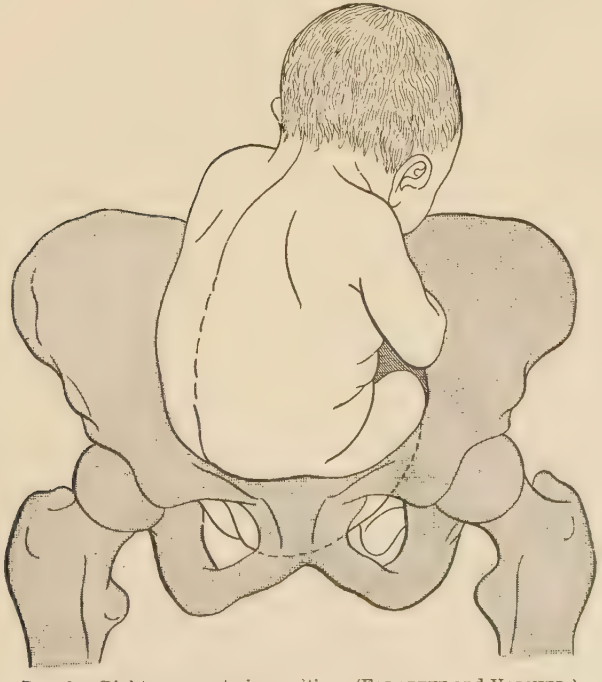
FACE. Left mento-posterior position. (FARABEUF and VARNIER.)

FIG. 172.



Breech Left sacro-anterior position. (FARABEUF and VARNIER.)

FIG. 173.

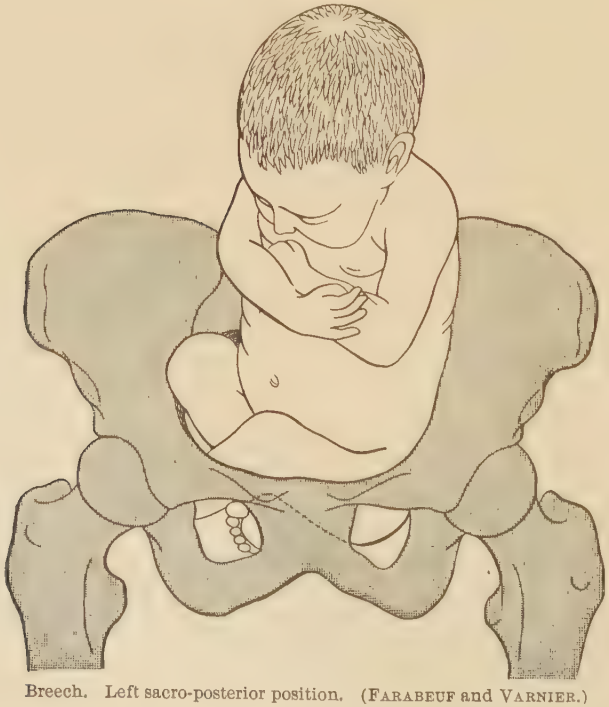


Breech. Right sacro-anterior position. (FARABEUF and VARNIER.)

FIG. 174.

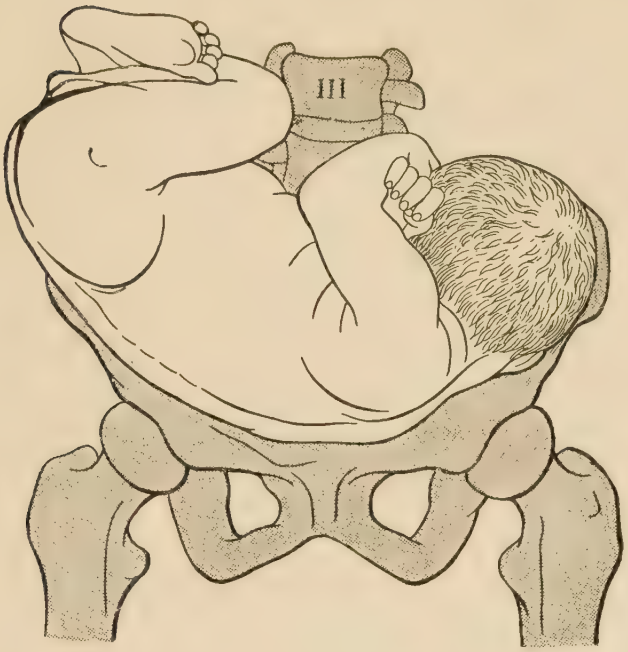
Breech. Right sacro-posterior position. (FARABEUF and VARNIER.)

FIG. 175.



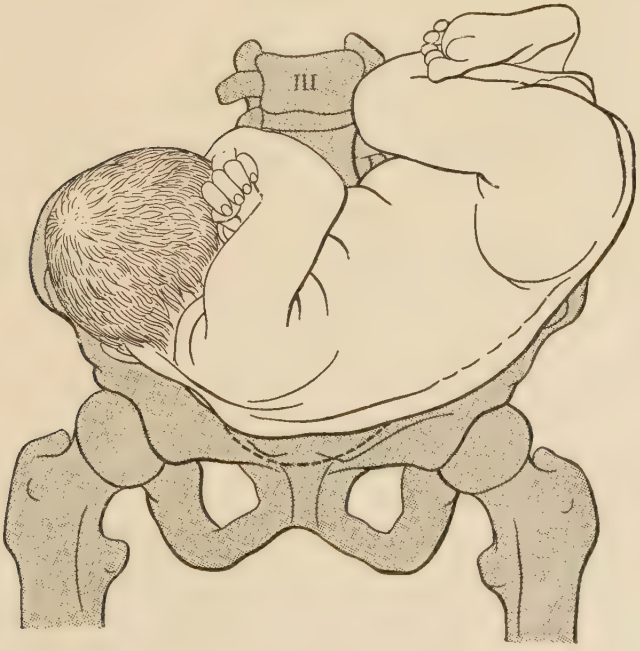
Breech. Left sacro-posterior position. (FARABEUF and VARNIER.)

FIG. 176.



Shoulder. Left scapulo-anterior position. (FARABEUF and VARNIER.)

FIG. 177.



Shoulder. Right scapulo-anterior position. (FARABEUF and VARNIER.)

FIG. 178.

Shoulder. Right scapulo-posterior position. (FARABEUF and VARNIER.)

FIG. 179.

Shoulder. Left scapulo-posterior position. (FARABEUF and VARNIER.)

CHAPTER VIII.

THE MECHANISM AND CLINICAL COURSE OF NORMAL LABOR.

Definition of Normal Labor. The term eutocia is applied to labors which terminate without artificial aid and without injury to mother or child. All such labors are in a sense natural or normal, and in most obstetric text-books are so classified. In the present work the term *normal labor* will be restricted to labors in which there is no element of dystocia, those, in other words, in which all the mechanical elements are normal and which are not rendered dangerous to mother or child by complications independent of the mechanism. Under this definition only uncomplicated labors in which the vertex presents in anterior position will be classed as normal.

Stages of Labor.

Labor comprises three stages:

The first stage, or stage of dilation, ends with the full dilation of the utero-cervical zone.

The second stage, or stage of expulsion, ends with the birth of the child.

The third stage, or placental stage, ends with the expulsion of the placenta and membranes and the complete retraction of the uterus.

The Duration of Normal Labor.

It is difficult to determine clinically the precise moment when labor begins. For practical purposes it is sufficient to date the onset of the parturient process from the time the woman is conscious of regularly recurring uterine contractions. In many instances, however, occasional pains may be felt for several days before labor is actively established. On the other hand, considerable dilation is very frequently accomplished without pain. Sometimes the labor may cease wholly for a time after it has continued for several hours.

The time occupied by the process of dilation varies greatly in different cases. Other things being equal, it is shorter in multiparæ than in primiparæ, since the soft parts offer less resistance after the first childbirth. It is especially prolonged in aged primiparæ, owing to excessive rigidity of the cervix uteri and of the pelvic floor in that class of parturients.

In typical normal conditions the average period from the beginning of active labor to complete canalization of the utero-cervical zone may fairly be stated at about fifteen hours for primiparous and about eight hours for multiparous women.

The average length of the second stage is approximately two hours in the primipara and one hour in the multipara.

The expulsion of the placenta usually takes place within a period varying from a few minutes to two hours after the birth of the child. The average period is about twenty minutes.

The average duration of labor in 100 primiparæ at the Long Island College Hospital was seventeen and one-quarter hours; in 100 multiparæ it was nine hours.

Causes of the Onset of Labor.

A process like labor, involving so extensive coördinate muscular action, implies the existence in the nervous system of controlling motor centres for the regulation of the uterine contractions. Though it has been sufficiently established that there is such a centre in the medulla, from which impressions travel, probably down the cord and through the sacral plexus to the uterus, rhythmical contractions are not solely dependent on this centre, as is proved by the fact that contractions go on after connection with the medulla has been severed. For example, rhythmical contractions have been known to take place in the horn of a uterus which had been removed while labor was going on. In addition to the nerve centre in the medulla we have the cervical ganglion, an extensive plexus of nervous matter lying on the posterior vaginal fornix and intimately connected with the uterus by numerous filaments. It is formed by the union of nerve cords from the hypogastric plexus, and it receives filaments from the second, third, and fourth sacral nerves. Whether the motor impulses travel by the cord or pass by the path of the sympathetic trunk is a question that cannot be answered finally at the present time. Lusk and others have reported cases of successful labor in women having paralysis of the lower extremities, retention of urine, and incontinence of feces. Observations of this character would seem to show that the cord is not the only route by which impulses are transmitted. Charpentier says the influence of the spinal cord over uterine contractions cannot be denied, for in women who have paralysis, uterine contractions, if less painful, are also very feeble, and if a few such had easy deliveries, yet in the majority labor is tedious from feeble uterine contractions. Besides the centres just mentioned, Dembo found collections of ganglionic cells between the peritoneal and the muscular walls of the uterus and groups of cells lying in the anterior vaginal wall which he believes to be uterine motor centres. Jewett reports a case in which after a Cœlio-hysterectomy the uterus, which was totally relaxed at the moment of amputation, contracted to a hard globe shortly after its removal from the abdomen.

Thus there are three motor centres which may give rise to contractions of the uterus—a centre in the medulla, the cervical ganglion, a collection of ganglia in the anterior walls of the vagina and one in the walls of the uterus. Of the relative importance of these centres we have no definite knowledge.

A great many theories have been advanced to account for the onset of labor, but none of them is entirely satisfactory, since none applies to all cases. All we can say at present is that labor is not the result of any one, but is due to the concurrent operation of a number of causes. These act by inducing uterine contractions, or perhaps it would be better to say by increasing the painless rhythmic contractions which are present in marked degree throughout the entire period of pregnancy. Among the probable causes of the active uterine contractions of labor the most important are the following:

1. Loosening attachment of the ovum, converting it into a foreign body.
2. Growing irritability of the uterine muscles.

3. Distension of the uterus by the growing ovum.
4. Excess of carbon dioxide in the blood.
5. Mental impressions.

1. **Loosening Attachment of the Ovum.** Separation of the *decidua vera* begins with the first active contractions of the uterus. The separation may be the result of a number of contributing factors. It has been held, for example, that fatty degeneration of the decidua occurs in the latter part of pregnancy; but doubt has been thrown upon the correctness of this assumption.

The *decidua vera* is divided into two parts. One part consists of an outer, dense, membranous layer of large cells resembling pavement epithelium; the other part, of a layer of much looser texture in which are found the large decidual glands. It is in this spongy layer that the separation of the decidua takes place. In this layer toward the end of pregnancy the trabeculæ enclosing the spaces of the network have been observed to decrease in size from $\frac{1}{500}$ of an inch to $\frac{1}{2500}$ of an inch. The layer seems to shrivel and thus to permit easy separation. The occurrence of hemorrhages, the result of the compression and tearing caused by the violent uterine action, also tends to detach the ovum from the walls of the uterus, and may act to intensify the pains already established. This separation of the decidua from the uterine wall makes the ovum in part a foreign body, and this explains the continuance of the expulsive efforts.

2. It is a matter of common observation that the uterus responds more readily to stimuli in the later than in the earlier months of gestation. Toward the end of pregnancy uterine contractions are excited by causes that are wholly inoperative at an earlier period. Molecular alterations in the protoplasm of the hypertrophied muscle fibres have been invoked in explanation of the increasing irritability of the uterus during the course of pregnancy.

3. **Distension of the Uterus.** The growth of the gravid uterus is a result in part of development of the uterine muscularis, in part of distension of the uterine parietes. There is not only hypertrophy and hyperplasia, but as well, it is assumed, a rearrangement of the muscular fibres, so that, instead of lying side by side, they are disposed more nearly end to end. According to this theory, when the limit is reached and growth and distension can go on no further, then labor begins.

Power likened the evacuation of the uterus to the emptying of viscera such as the bladder and the rectum. These permit distension to a certain extent and then expel their contents.

4. **Excess of Carbon Dioxide in the Blood.** Brown-Séquard has shown that the excess of carbon dioxide in the blood of pregnant animals will bring on uterine contractions. This effect may be produced directly or through the uterine motor centre. As the fœtus grows, it demands more nutriment, and there must be a corresponding increase of the products of tissue waste, including carbon dioxide. The presence of carbon dioxide in the blood of the placenta is accounted for in several ways, but most writers agree in this, that it is the result of some interference with the passage of the blood through the placenta. Leopold and Ruge believe it to be due to the formation of thrombi in the placenta. Friedländer explains the formation of blood coagula in this organ by the penetration into the uterine sinuses of the cells that form in the serotina

about the eighth month. Another explanation of the increase of the carbon dioxide is based on the fact that the trabeculæ of the sinuses are observed to decrease until, at end of pregnancy, they are about one-fifth their former size. This may be the result of cell infiltration of the walls and consequent contraction. When the venous blood has accumulated to a certain amount the contained carbon dioxide stimulates the uterine contractions, and labor is established.

5. **Mental Impressions.** It is necessary only to mention the effect of great grief as an etiological factor in abortion to call to mind how important a part the emotions may play in inducing labor. But such agencies as these and slight muscular strains, jars, and falls happening near the close of gestation, and the descent of the fœtus low in the pelvis, due to yielding of the cervix, cannot be viewed as essential causes of the onset of labor. Usually the establishment of labor is wholly independent of such influences.

In the existing state of our knowledge it is impossible to say which of the many possible causes are most active in bringing about the final result.

The Clinical Phenomena of Beginning Labor.

The more important phenomena of labor are those which pertain to the uterus. These will next be considered.

Labor Pains. Contractions of the uterus occurring during labor are painful and they are known in all languages by the word which expresses pain. As is true of pain in general, sensibility to the pains of labor differs in different women. Labors wholly unattended with pain have been recorded, but they are exceedingly rare. It is also said that patients have been delivered painlessly in a condition of hypnotic sleep, but such experiences are among the rare curiosities of obstetric practice. The cause of painful sensations in the early part of labor is the distension of the cervix and the compression of nerve filaments in the contractile segment of the uterus, and in the latter part the suffering is greatly intensified by stretching of the vagina and vulva and compression of the nerve-trunks in the pelvis.

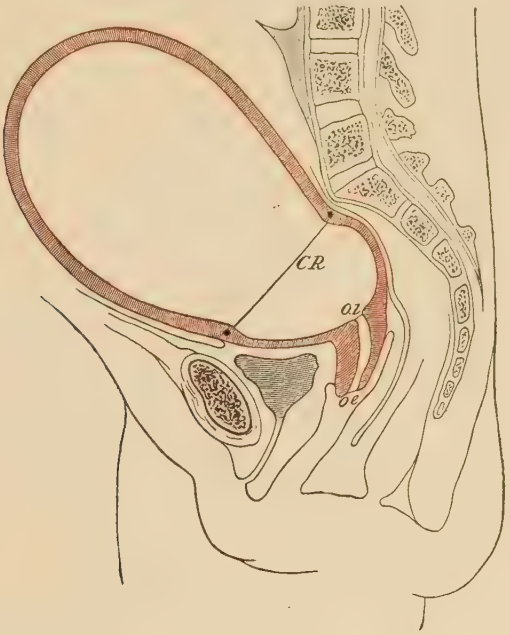
The contractions are *involuntary*. The patient cannot initiate them nor can she stop them when they have begun, although in the stage of expulsion she can assist them by voluntarily bringing the abdominal muscles into play. Notwithstanding the automatic character of the uterine contractions, mental impressions may affect them in a marked degree; for example, the arrival of the physician may retard, and even for a short time arrest, the labor. The pains are likely to be inhibited, too, by the reflex effect of a full bladder or rectum.

The pains are *intermittent*, and the interval between them varies with the stage of progress. The intervals of repose grow shorter as the labor progresses, until finally, at the end of the second stage, the expulsive efforts are almost continuous. The intermittent character of the pains is essential to the safety of the fœtus. During the height of a uterine contraction the placental circulation is almost wholly interrupted, and the fœtus, moreover, suffers powerful compression. Under persistent uterine contraction it would soon perish.

The contractions are *peristaltic*, proceeding from one extremity of the

uterus to the other. The direction of this contraction wave is from fundus to cervix. In some of the lower animals contractions have been observed to pass from cervix to fundus, but such phenomena are doubtless exceptional and abnormal. The wave is said to last from one-third to two-thirds the length of the labor pain. Assuming that the average

FIG. 180.



CR. Contraction ring, or retraction ring, at onset of labor. *oi.* Os internum. *oe.* Os externum. (SCHROEDER.)

duration of a pain is one minute, the peristaltic wave would last from twenty to forty seconds.

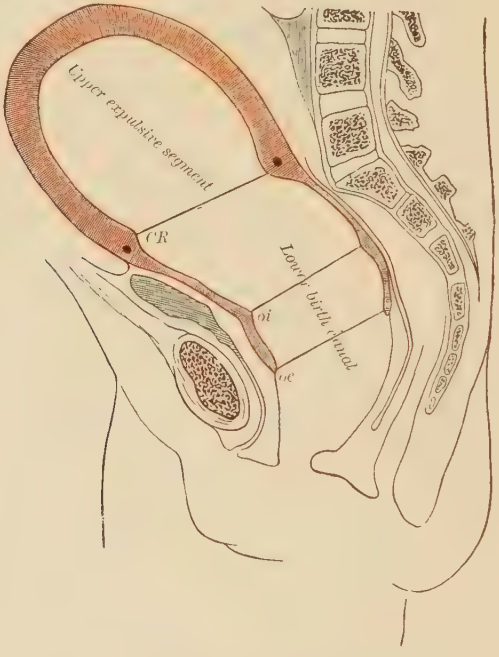
THE MECHANISM OF DILATION.

Upper and Lower Uterine Segments. The gravid, like the non-gravid uterus, presents two general divisions, the body and the cervix. The body of the parturient uterus, however, resolves itself into two parts, designated respectively the upper and the lower uterine segment. The plane which separates the two segments lies nearly at the level of the utero-vesical fold of peritoneum. This plane represents the level at which the conical lower portion of the cavity begins to be smaller than the greatest sectional plane of the fœtal head which must pass through it. The lower uterine segment, therefore, comprises all that portion of the body of the uterus which, together with the cervix, must undergo dilation preparatory to the expulsion of the fœtus. The upper uterine segment includes approximately the upper two-thirds of the uterus; the lower segment and the cervix, which are of nearly equal lengths at the beginning of labor, constitute the remaining third. Fig. 180.

In the course of labor the cervix to some extent merges into the lower uterine segment. Thus the latter segment as fully developed is derived mainly from the body of the uterus, partly from the cervix.

Uterine Retraction. During labor the expellent force obviously must be supplied by the contractions of the upper uterine segment. The lower segment is concerned in dilation, and after dilation is fully established it has become entirely passive. The dilation which takes place in the cervix and the lower uterine segment as the upper segment contracts is a phenomenon somewhat comparable to what occurs in other hollow viscera during the expulsion of their contents. It is in part a relaxation and in part the result of distension.

FIG. 181.



Retraction ring at end of first stage of labor. Lower birth canal consists of the lower uterine segment and the cervix. (SCHROEDER.)

oe. Os externum. *oi.* Internum. *CR.* Contraction or retraction ring.

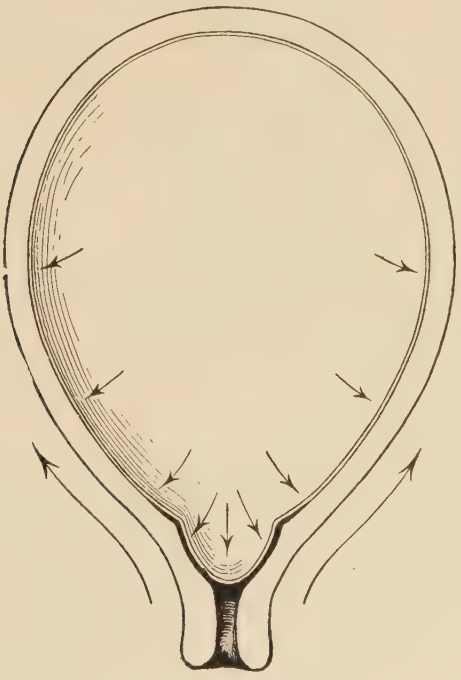
After labor is established the musculature of the upper uterine segment becomes thickened, and that of the lower segment as it dilates is correspondingly thinned. The line of demarcation between the thickened upper and the thinned lower segment presents a ridge which often may be made out on palpation over the abdomen during a pain. Frozen sections show that this ridge is more pronounced posteriorly. Fig. 181.

This ridge is called the ring of Bandl, from the name of the authority who first described the differentiation of the uterus into the contractile upper and the non-contractile lower segment. It is also known as the contraction or the retraction-ring. The latter is perhaps the preferable term. The situation of the retraction ring, which at the onset of labor is below the pelvic brim, rises higher as the pains go on, and in abnormally long or

obstructed labors may reach nearly the level of the navel. It should be observed that Bandl's ring is perceptible only during a uterine contraction.

The term retraction applies to the process by which the thickening takes place in the upper segment. It is due mainly, if not wholly, to persistent shortening and thickening of the muscular fibers. While the shortening of the fibres during the uterine contractions is followed by elongation in the intervals, the primal length is not fully restored. It is commonly taught that retraction is due in part also to rearrangement of muscle fibres. Fibres, it is assumed, which at the beginning of labor lie nearly end-to-end, in course of retraction, come to lie nearly side by side. The retraction of the upper segment of the uterus increases as

FIG. 182.



Effect of the uterine contraction in the first stage of labor. (BUMM.)

the volume of its contents is diminished. The retraction, in other words, progresses in proportion to the progress of the birth.

Dilation of the Cervix. In the dilation of the cervix three agencies are concerned:

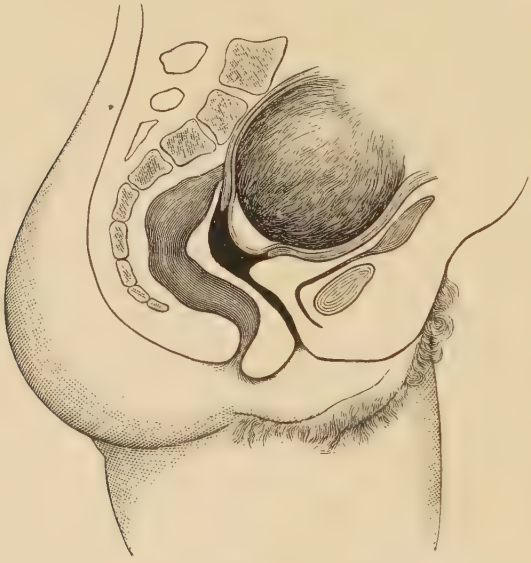
1. Softening of the cervical tissues.
2. The hydrostatic pressure of the bag of waters.
3. The contraction of the longitudinal fibres of the upper uterine segment.

1. PROGRESSIVE SOFTENING OF THE CERVIX, commencing below and extending upward, is normally present from the early months of pregnancy, and is a valuable sign of this condition. Contractions of the

uterus, by interfering with the return circulation, cause over-distension of the cervical veins and lymphatics, and there is infiltration of the tissues with serous exudate; at the onset of labor the infiltration and softening rapidly increases.

The yielding of the cervix in the first stage of labor is doubtless, too, in part a physiological relaxation analogous to that which takes place in sphincter muscles.

Fig. 183



Bag of waters during a pain.

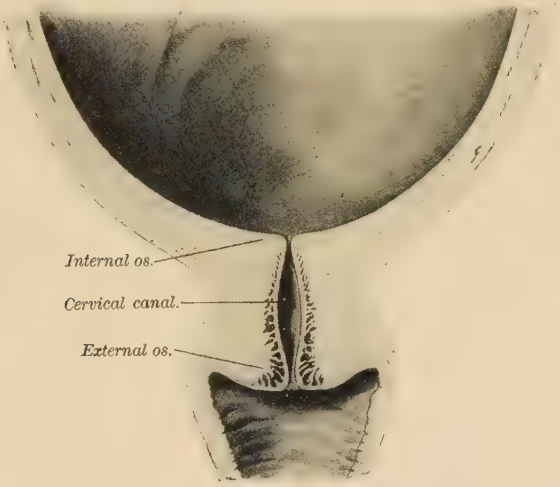
2. Hydrostatic Pressure of the Bag of Waters. The second agency in securing dilation—pressure from the bag of waters—is a very important one. Its value is most clearly brought to our attention when we have lost it. If, by mischance, early rupture of the membranes has occurred, and the waters have drained away, the labor is termed a dry labor. Such labors are proverbially likely to be of long duration and may be predjudicial to mother and child.

During a uterine contraction, as the cervix opens, the lower portion of the membranes, loosened from its attachment by the first active uterine contractions, insinuates itself into the opening. Since the fluid within the membranes transmits the force of the uterine contraction equally in all directions, the bag of waters is distended laterally as well as downward, exerting an expansive pressure directly upon the walls of the cervix. The lateral expanding force acts in the radii of the resisting ring. Other things being equal, the hydrostatic pressure increases with the area of the surface on which it acts. The dilating force becomes greater, therefore, in proportion as the dilation progresses. Fig. 181.

With premature rupture of the membranes we lose the efficient hydrostatic wedge, and have in its place the presenting fœtal pole. This

substitutes a solid body for the water bag. The fœtal pole is inferior in dilating power to the equable hydrostatic pressure of the bag of waters, but moulding and the caput succedaneum, yet to be described, add some-

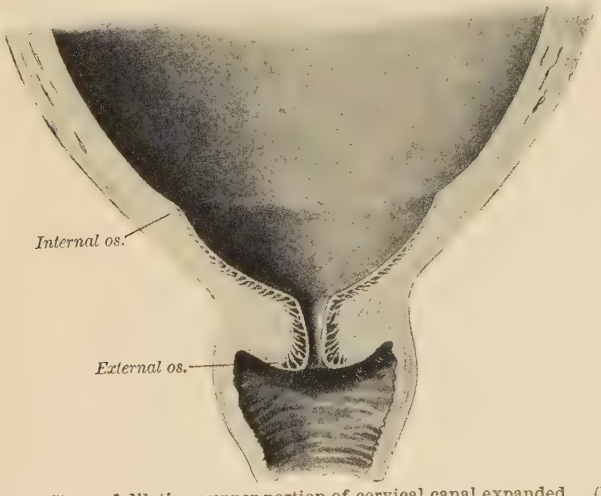
FIG. 184.



Cervix of primipara at beginning of labor. (BUMM.)

what to its efficiency as a dilating wedge. They compensate in some degree for the loss of the hydrostatic pressure of the sac of waters. In the

FIG. 185.

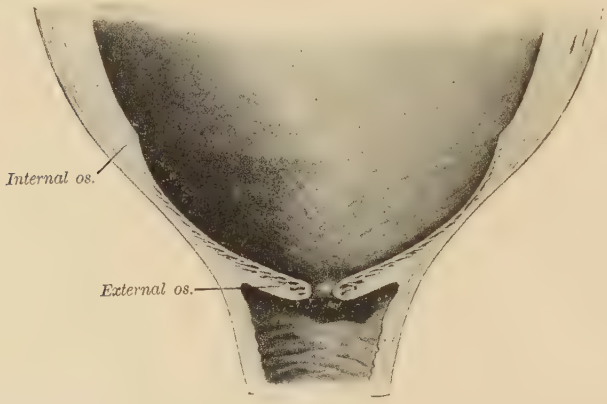


Primipara. Stage of dilation ; upper portion of cervical canal expanded. (BUMM.)

later weeks of pregnancy the cervix as we have seen is softened and its canal is sufficiently open to admit a finger.

3. Action of the Longitudinal Muscular Fibres of the Uterus. In the uterine contractions of beginning labor the pull of the contracting longitudinal muscular fibres of the upper uterine segment acts

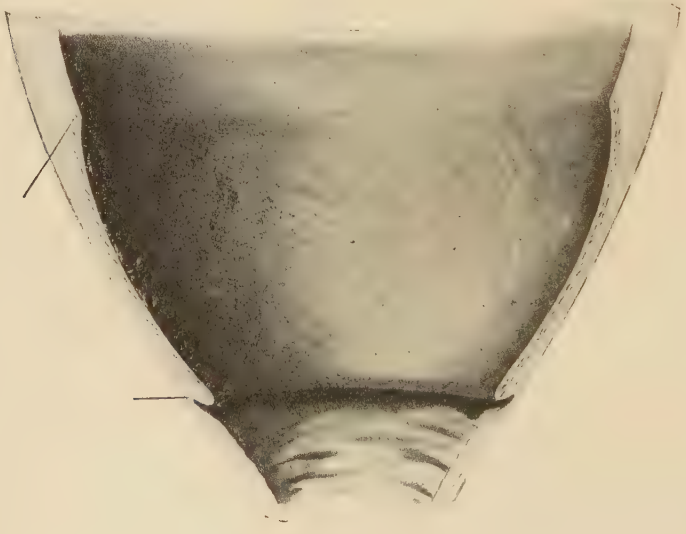
Fig. 186.



Primipara. Cervix above external os fully dilated. External os still closed. (Bumm.)

to dilate the cervical muscular rings and to drag them upward over the lower pole of the ovum. The oblique muscular bundles act in some degree with like effect. The circular bundles of the cervix are inferior in

Fig. 187.

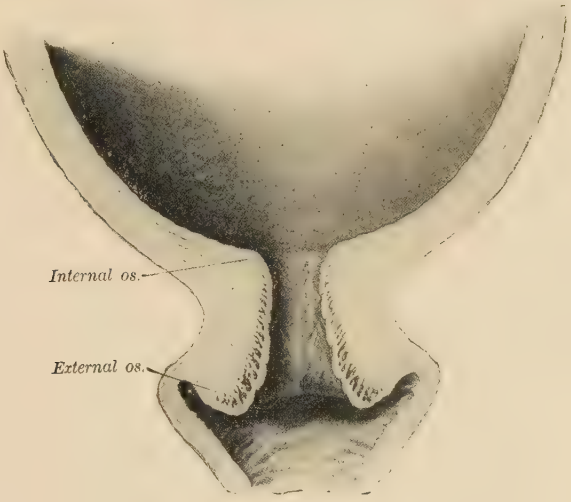


Primipara. End of first stage. (Bumm.)

strength to the musculature of the body of the uterus and they yield to the greater force. Obviously as the cervical dilation progresses the

mechanical advantage of the contractile upper uterine segment increases.

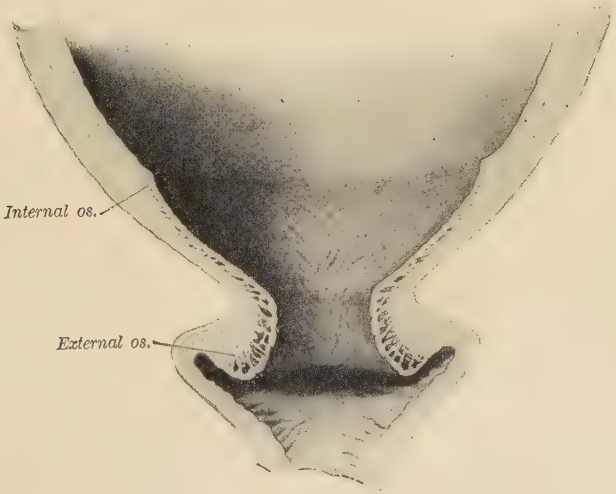
FIG. 188.



Multipara. Beginning dilation. (BUMM.)

Changes in the Shape of the Uterus. During the first stage of labor and especially in the second, the uterus becomes elongated in proportion as

FIG. 189.



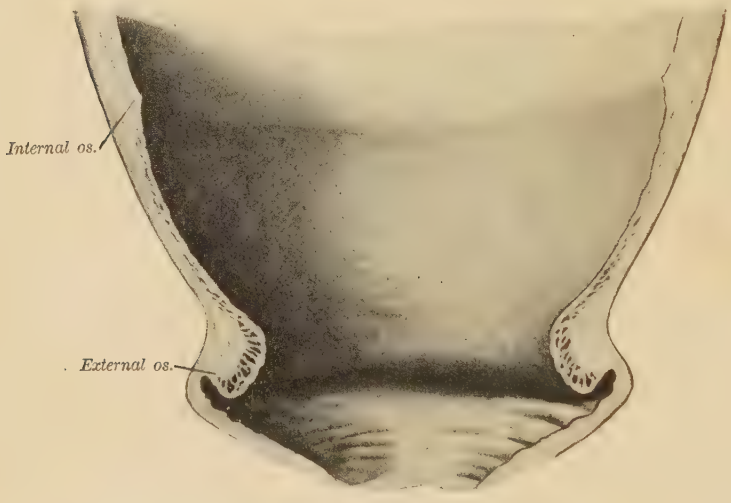
Multipara. Dilation well established; showing relative expansion of upper and lower portions of cervix. (BUMM.)

the lower segment becomes thinned and stretched The antero-posterior and the transverse diameters of the uterus are correspondingly diminished.

The body of the uterus is drawn forward during a pain by the contraction of the round ligaments.

The Cervical Rings. In the primipara the first effects of the dilating force are observed at the internal os. This expands with the pains, and for a time contracts again in the intervals. As the dilation progresses the os internum becomes permanently relaxed. Early in the first stage a digital examination reveals two distinct resisting rings, one at the external and one at the internal end of the cervical canal. The canal itself preserves a pronounced fusiform shape. Later, the os internum becomes permanently obliterated, having merged into the lower uterine segment.

FIG. 190.



Multipara. End of first stage. (BUMM.)

The ovum from this time rests upon the external ring or the os externum. This in turn as the labor goes on is gradually expanded till finally the walls of the dilated utero-cervical zone and those of the vagina form one continuous canal, with a barely perceptible interruption at the external ring of the cervix uteri. (Figs. 184–187.)

In the multipara the dilation of the entire cervical canal is practically simultaneous. By the time the os internum has been effaced, the os externum is fully expanded. (Figs. 188–190.)

Retraction of the Pubic Segment of the Pelvic Floor. Toward the close of the first stage and during the earlier part of the second, as the cervix is drawn upward over the head, the bladder is lifted partly above the pubic bone by the traction of the longitudinal muscular fibres of the uterus. The bladder is thus in some measure protected from injury by the pressure of the head as it traverses the pelvic canal.

The Clinical Phenomena of the First Stage.

The Pains. The patient realizes that she is in labor when she begins to suffer regularly recurring pains in the back. From this region as labor is fully established the pains extend to the front and often are felt running down the thighs.

The initial labor pains most frequently come on in the early part of the night. They at first recur at intervals of twenty to thirty minutes, but as the labor goes on the intervals become progressively shorter.

For a time they may differ little in character from the so-called false pains frequently experienced during the later weeks of pregnancy, but they are distinguished by a more or less rhythmical recurrence and by growing strength and frequency.

The pains are sharp and "nagging." The patient walks restlessly about the room, sits in a chair, or at times takes to the bed. If she is on her feet when a contraction begins, she bends over a chair or other object near at hand. Her face during the pains is suffused, owing to fixation of the respiratory muscles. As the dilation becomes nearly complete, reflex vomiting is not infrequent. Its occurrence may usually be taken as evidence that the first stage of labor is well advanced.

The *degree of pain* is variable. Often the pains of dilation are not so well borne as are those that come later, for the reason that the parturient is impatient of suffering which seemingly results in no progress. As the intervals shorten, the pains strengthen in both the first and the second stage of labor.

The Show. By expansion of the cervix and the lower uterine segment, the membranes in the lower part of the uterus are separated from the uterine wall, causing a slight discharge of blood which is spoken of as the show; at the same time usually the mucous plug is expelled from the cervix.

The Cervical and the Vaginal Secretions become more profuse as labor is established. They serve as a lubricant to the passages in preparation for the expulsion of the fœtus.

The Irritability of the Bladder and the Rectum, already provoked by the lightening, is increased when active pains begin. Urinary and fecal evacuations occur more frequently than before.

The Cervix. The lower border of the cervix becomes thin and sharply defined during the pains. In multiparæ the lower part of the cervix is more patulous, and offers less resistance to the advancing bag of membranes than in primiparæ.

The Pulse. The maternal pulse increases in frequency during a pain; the heart-tones of the fœtus are less distinctly audible, and the pulse-rate is slower than in the intervals. The fall in the fœtal pulse-rate is due to increased vascular tension caused by the compression to which the fœtal mass is subjected during a uterine contraction.

Rupture of the Bag of Waters. On full dilation of the cervix the membranes usually rupture. Yet rupture may take place at an earlier period, or may not happen till the moment of expulsion. Very rarely a full-term child may be born with the membranes unbroken.

Rupture of the bag of waters is announced by a gush of water from the vagina. The quantity of liquor amnii expelled will depend on the extent to which the lower uterine segment is occluded by the presenting

part. It is not always safe to rely on the patient's statement that the membranes have ruptured. She may be misled by leakage of urine from the bladder. If the discharge is due to rupture of the membranes there is usually more of it between than during the pains, since the head then recedes and allows the waters to escape more freely Sometimes an accumulation of fluid has taken place between the amnion and chorion, and this may be liberated by rupture of the chorion, the amnion still remaining intact. It is claimed too that sometimes amnial liquor may transude through the unbroken membranes.

After the membranes give way the uterus retracts as the waters escape, and the pains are resumed with new vigor.

Emotional Influences. The progress of the labor in this stage is easily influenced by emotional causes. The presence of a strange face or the narration of the horrors of previous cases by friends or by the nurse may stop the pains for a long time.

The Bearing of the Patient differs greatly in different women; some apparently suffer little while others complain bitterly.

The Mechanism of Expulsion.

The mechanism of the second stage of labor concerns especially the movements which the fœtal head and trunk undergo in course of their transit through the birth-canal. Since the head diameters are larger and less compressible than are those of the trunk, the mechanism is most important as relates to the head.

1. The head movements are: Descent, flexion, rotation, extension, restitution, external rotation.

Descent. During the first stage of labor, as has been seen, the force of the uterine contractions is expended in dilating the utero-cervical zone. At the beginning of labor, if the membranes are intact, the intra-uterine pressure developed by a uterine contraction is, in accordance with the familiar law of hydrostatics, brought to bear upon the fœtus equally in all directions. After partial dilation of the cervix and the formation of the bag of waters the head sinks into and partially occludes the lower uterine segment. The main body of liquor amnii behind the head is termed the hindwaters, that in advance of it, the forewaters. Under the pressure developed in the hindwaters during a uterine contraction the head advances as the sac of forewaters protrudes. After the membranes rupture the head descends with a moving force which is measured by the propelling power less the resistance opposed by the birth-canal.

So long as the waters have not all escaped the expellent force is transmitted to the head in part through the liquor amnii. After the waters have drained away the fœtal parts are consolidated in a compact mass by the grasp of the uterus, and the propelling force is transmitted in great measure through the entire fœtal ovoid. The lateral compression exerted by the uterine contractions acts to steady the fœtal mass and also adds to the extruding force. The descent of the head is due in part to the fact that the elongation of the fœtal ovoid under the compression exerted by the uterine contractions is somewhat greater than the elongation of the uterus itself.

Flexion. Flexion is in part primary, being the normal posture of the fœtus *in utero*. It is increased when the head begins to encounter the resistance of the lower uterine segment, and becomes complete sooner or later after engagement in the bony pelvis. The mechanism is as follows: The head is so attached to the trunk that its sincipital is longer than its occipital pole. The head, in other words, corresponds to a lever of unequal arms, the occipito-atlantoid articulation being the pivotal point and the sincipital arm the longer arm of the lever. Fig. 191. When the head begins to encounter the resistance of the birth-canal this resistance, even though equal at the two poles, must act with greater effect on the longer arm of the lever. This advantage in normal conditions is increased by the primary flexion. The chin, therefore, dips toward the sternum. The flexion is increased as the opposing forces increase, and becomes complete when the head meets the resistance of the bony walls of the pelvis.

Another factor in bringing about the flexion of the head is to be found in the tendency of the cephalic ellipsoid to adapt itself to the shape of the canal through which it descends. Under the pressure of the pelvic walls its long axis naturally falls into relation with the axis of the birth-canal.

Fig. 191.

Illustrating the different lengths of the frontal arm, FB, and the occipital arm, BO, of the lever presented by the fœtal head.

The advantage of flexion is obvious. It brings the smallest, or suboccipito-bregmatic, circumference of the head in relation with the girdle of resistance in place of the larger occipito-frontal circumference.

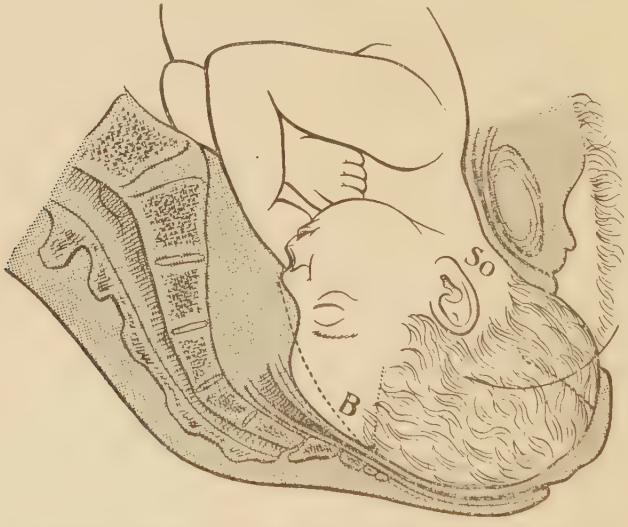
As has been explained the head is fully flexed when it enters the brim, or under normal conditions it soon becomes so; thus all motion in an antero-posterior direction is checked, but some measure of lateral mobility still remains. A certain degree of lateral obliquity of the head may obtain as the head enters the pelvis. When the head descends with its planes parallel to those of the pelvis, the descent is said to be synclitic. Lateral inclination of the head toward either shoulder is termed asynclitism. When the head is inclined toward the posterior shoulder, the anterior parietal bone presents and the obliquity is distinguished as anterior asynclitism, Naegle's obliquity. When the inclination is toward the anterior shoulder the posterior parietal bone presents and the obliquity is known as posterior asynclitism. Anterior asynclitism at the brim occurs more commonly in multiparæ with lax abdominal walls since in such cases the upper pole of the fœtus more readily falls forward. Posterior asynclitism is oftener observed in primiparæ whose tense abdominal walls hold the pelvic end of the fœtal ovoid well backward. After passing the brim the

planes of the head in practically all cases conform to those of the pelvis, the descent is synclitic.

Rotation. When the head reaches the pelvic floor the suboccipito-frontal diameter of the head which passed the brim in a direction parallel with the oblique diameter of the pelvis begins to turn till at the moment of expulsion it is nearly parallel with the antero-posterior diameter of the pelvis, the occiput normally swinging to the front.

The chief agency in bringing about rotation of the head as it traverses the pelvis is the action of the pelvic floor. The floor of the pelvis may be considered as made up of two lateral halves, each of which slopes downward, inward and forward. That pole of the fœtal head which lands first on one lateral half of the floor glides downward, inward, and forward, and emerges from the outlet beneath the pubic arch. When the head is normally flexed the occipital pole first reaches the floor, and as it descends, is rotated inward to escape under the arch of the pubes.

FIG. 192.



Beginning distention of pelvic floor. (FARABEUF and VARNIER.)

It will be noted that flexion is a prerequisite to normal rotation. It is only when the occipital pole of the head dips lower in the pelvis than the sincipital that anterior rotation of the occiput is likely to prevail. Should the sinciput reach the pelvic floor at the same time as the occiput the former may be rotated forward under the symphysis, the latter going backward into the sacral hollow.

The influence of the planes or grooves of the bony pelvis, on which stress has been laid by certain obstetric writers, is of secondary importance in effecting rotation of the head. That the action of the pelvic floor is the principal agency in causing rotation would seem to be sufficiently established by the experiment of Dubois. Dubois showed that when the head of a fœtus was pushed through the pelvis of a woman who had died before or immediately after delivery, no matter in what position he placed the occiput, if it struck the pelvic floor in advance of the sinciput, it would

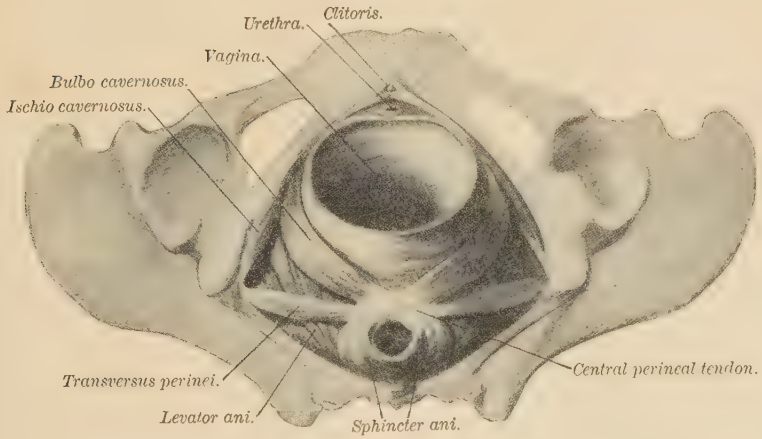
turn forward, provided the floor had not been injured by rupture or overstretching. After several repetitions of the experiment the floor became overstretched and the rotation was likely to fail.

Edgar, of New York, screwed a swivel into the head of a fœtus half an inch behind the small fontanelle. Attaching a cord to the ring of the

FIG. 193.

Beginning extension of head. (FARABEUF and VARNIER.)

FIG. 194.



Muscles of the pelvic floor as they begin to be stretched by the pressure of the head seen from below. (BUMM.)

swivel, he repeatedly dragged the head through the pelvis of a woman dead after recent delivery. The occiput invaribly rotated to the front, even when the head entered the pelvis in occipito-posterior position, so long as the pelvic floor retained its integrity. When the tonicity of the floor became impaired, the head traversed the pelvis in very nearly the same position as it had entered.

After the leading pole begins to pass the lower end of the symphysis its forward rotation is favored by the fact that this direction is that of least resistance.

FIG. 195.

Maximum distension of pelvic floor. Equator of head about to pass. (FARABEUF and VARNIER.)

FIG. 196.

Occiput rides up in front of symphysis. Pelvic floor retracts. (FARABEUF and VARNIER.)

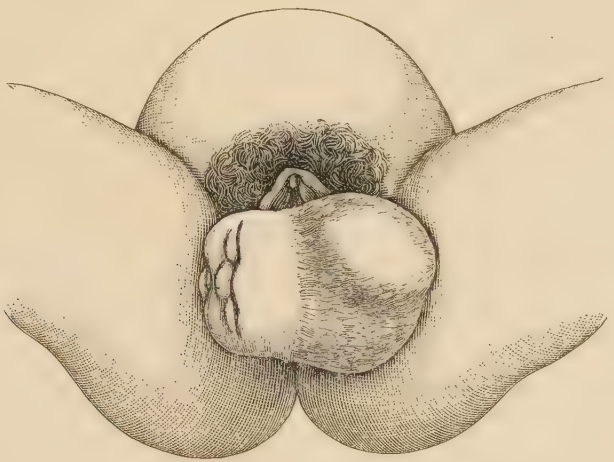
Extension. By the time the occiput is about to emerge under the pubic arch the sinciput rests firmly upon the coccyx and lower portion of the sacrum. The biparietal diameter lies in the grasp of the ischial tuberosities and the vertex distends the pelvic floor. Fig. 192. The long diameter of the head lies nearly in line with the sacro-pubic diameter of the pelvis.

As the head is driven down the distension of the pelvic floor is increased. The floor grows progressively thinner as it stretches under the pressure of the advancing head, and becomes more and more

elongated antero-posteriorly till at the moment of expulsion the length of the sacral segment, from coccyx to the posterior edge of the vulva, is 6 inches.

As the occiput escapes under the arch of the pubes it rides up in front of the symphysis till the nucha rests against the subpubic ligament. The forehead then passes the coccyx and the head is expelled mainly by descent in the line of the birth-canal, partly, at the last moment, by a movement of extension, the vertex, the forehead, and the face successively sweeping over the free edge of the sacral segment of the pelvic floor. Figs., 193, 195, and 196.

FIG. 197.



Fœtal head after restitution in L. O. A. position. Shows also caput succedaneum. (RIBEMONT-DESSAIGNES and LEPAGE.)

Recession of the Head between the Pains. Throughout its descent the head advances with the pains and recedes in the intervals. In normal conditions this alternate advance and recession continues during expulsion till the head is well within the grasp of the vulvo-vaginal ring. From this time no recession takes place between the pains.

Restitution. The rotation of the head in the course of its transit through the pelvis develops a certain degree of torsion of the neck. After the head is expelled the neck untwists. The head, therefore, immediately it is born, assumes a position corresponding to that in which it had entered the pelvis. This movement is termed restitution. It is of interest for the reason that it indicates the primary position. Fig.197.

External Rotation. The shoulders descend in the oblique diameter of the pelvis opposite that in which the head came down. They rotate, therefore, in a direction opposite that which the head had pursued. Rotation of the head is accordingly continued during the expulsion of the shoulders and in the same direction as that which obtained in the movement of restitution This supplementary rotation is termed *external rotation*:

Delivery of the Trunk. By the time the vertex appears at the vulva the shoulders begin to enter the pelvis. They engage in the oblique diameter opposite that in which the head entered. They rotate less perfectly than the head. The anterior shoulder is arrested behind the sym-

physis, the posterior shoulder rides over the pelvic floor and, as a rule, first appears at the vulva. After expulsion of the posterior, the anterior shoulder is disengaged and escapes. The breech in its descent through the pelvis undergoes only partial rotation. As the trunk is expelled it is followed by a gush of bloody water.

Clinical Phenomena of the Second Stage.

If the patient is very much fatigued from a long first stage she may sleep between pains. These brief periods of rest help to renew her strength and add efficiency to the pains. The parturient is more likely to sleep if chloral has been administered in the first stage.

The pains are more severe during the stage of expulsion, but the patient realizes with a sense of satisfaction that the head advances with the pains, and the hope of speedy relief fortifies her endurance.

When the occiput has reached the pelvic floor, the cavity of the pelvis is completely filled and the pressure of the head upon the bowel gives rise to marked rectal tenesmus. The sphincter ani becomes relaxed and one or more fecal evacuations usually take place as the head passes over the floor of the pelvis. The contractions of the abdominal muscles toward the close of the expulsive stage are reflex and wholly involuntary. As the head distends the vulvar ring the pains become so intense as sometimes to result in transient delirium.

A brief pause ensues on birth of the head. After a moment or two of rest, contractions recur and the shoulders pass; then the body, followed by a gush of bloody amniotic fluid, is expelled.

The second stage is now ended, and a period of a few moments follows before the pains are again renewed to expel the afterbirth.

Moulding of the Head. Even in typical normal labors, the head undergoes more or less alteration in shape as it is driven through the pelvis. This is an important fact in the mechanism of labor, since it conduces in marked degree to the adaptation of head to pelvis.

Under the influence of the pelvic pressure-forces the diameters in the grasp of the resisting girdle all are reduced, this reduction being compensated by elongation of the cephalic mass in the direction of the birth canal. The parietal bones overlap the occipital, sometimes also the frontal, and one parietal bone may overlap the other. The engaging diameters are thus diminished to the average extent of 6 mm., ¼ inch. The degree of moulding will obviously depend on the relative size of head and pelvis, the plasticity of the cranial vault and the force of the pains. The plasticity varies with the extent of ossification, which is not absolutely constant at the same stage of development.

Moulding is an essential element in the mechanism of the expulsive stage of labor not only by reason of adaptation of head to pelvis, but also because elongation of the head favors normal rotation by increasing the dip of the leading pole.

Caput Succedaneum. The caput succedaneum is an œdematous swelling which is developed on the presenting part in course of the birth. It is formed after rupture of the membranes. During a uterine contraction all parts of the fœtal mass are under pressure except that which offers to the examining finger within the girdle of resistance. The vessels of

the presenting part become engorged during the pains and a serous exudate takes place into the cellular tissues of that portion of the fœtal surface. See Fig. 197.

The size of the caput succedaneum will obviously vary with the degree of force which produces it. It is large, therefore, in prolonged and difficult labors. Its size affords a valuable sign in the vaginal examination of the degree of obstruction which the fœtus encounters in its passage through the pelvis.

The location of the caput succedaneum is of interest in the examination of the head after delivery as indicating the position in which the head had descended. In anterior positions it is situated at the posterior, and in posterior positions on the anterior aspect of the summit of the head. In left positions it occurs to the right, and in right positions to the left of the median line. A right occipito-posterior location of the caput, therefore, indicates a left occipito-anterior position of the head, and so on.

It should be remembered that the situation of the tumor may be modified when the head has been subjected to long-continued pressure in the lower portion of the birth-canal after partial rotation had taken place.

The caput, like moulding, by adding to the elongation of the leading pole of the head, promotes rotation. In labors in which the head furnishes the dilating wedge it adds to the efficiency of the dilator by increasing the acuteness of the wedge.

A similar swelling develops on the presenting part in other than cephalic presentations. To this it is customary to apply the same term on whatever part of the fœtal surface it occurs. The tumor usually disappears within twenty-four hours after birth.

The Mechanism of Placental Expulsion.

After expulsion of the child the uterus grows smaller by retraction and closes upon the placenta. When active contractions are resumed the placenta is gradually detached. As the seat of placental attachment shrinks during a uterine contraction, the placenta, not being sufficiently retractile to accommodate itself fully to the diminished area of the placental site, is partially torn from the uterine wall with each pain. Rarely it may happen that the placenta is wholly separated by the first strong contraction.

Expulsion may take place by either of the following mechanisms: Separation may begin at the placental margin and the placenta as it separates be rolled up laterally by the uterine contractions, the long diameter of the folded mass conforming to the long diameter of the uterus. The placenta is then expelled with its lower edge presenting. This is known as the method of Duncan who believed it to be the prevailing mechanism of expulsion. It obtains usually when the lower margin of the placenta is first to become detached. Fig. 198.

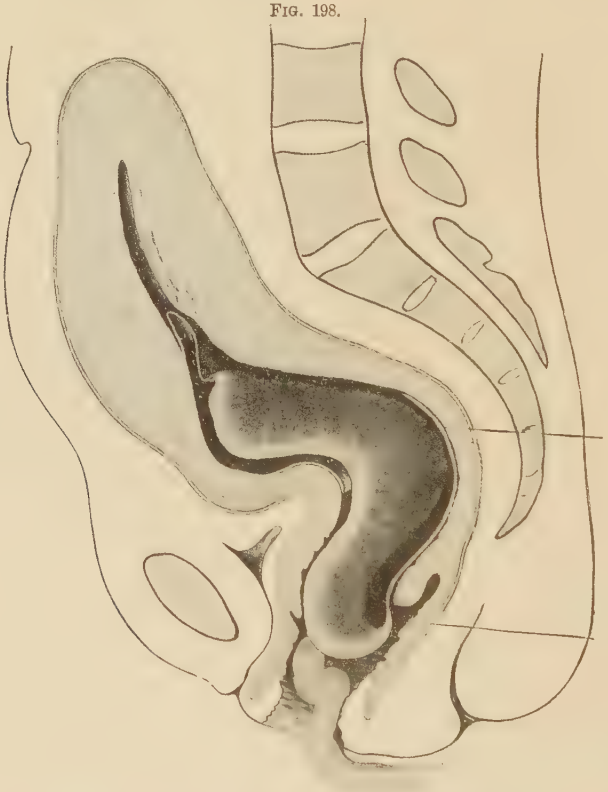
Detachment may begin over the central portion of the placental seat. Then as the uterus relaxes a retroplacental blood collection is formed. With each succeeding contraction the area of detachment is increased and the blood collection grows accordingly. The liberated por-

tion of the placenta is thrust downward toward the cervical opening and the afterbirth is expelled flatwise, by its amniotic surface. The latter mechanism Schultze held is the usual one and it has received his name. Fig. 199.

Either method may obtain and either is to be regarded as normal.

In Schultze's method the placenta is thrust downward through the rent in the membranes, the latter being peeled off by the traction of the placenta. In Duncan's method the lower portion of the membranes may appear together with the presenting edge of the placenta, the remainder following the afterbirth, or the membranes may be inverted as in the method of Schultze.

FIG. 198.



Duncan's method of placental expulsion. (BUMM.)

In exceptional instances the placenta may be extruded from the uterus according to Duncan and be expelled through the vulva according to Schultze.

THE CLINICAL PHENOMENA OF THE THIRD STAGE.

At a variable length of time after the child has been delivered the uterus again commences to contract, the placenta is gradually forced into the lower uterine segment or the vagina, and, when the tonicity of the abdominal and the pelvic floor muscles has not been too much im-

paired, may be expelled through the vulvar orifice. The membranes are dragged after it, sometimes promptly, sometimes peeling slowly from their uterine attachment. The average time of placental expulsion is about twenty minutes after the birth of the child. At the moment when the placenta is extruded from the contractile segment of the uterus the fundus rises slightly higher in the abdomen and a moderate fulness may be felt by the examining hand held upon the abdomen just above the symphysis.

The expulsion of the placenta when it takes place according to Schultze, is accompanied with a greater or less amount of clotted and of liquid blood. In Duncan's method of expulsion slight bleeding is nearly continuous from the time the lower placental margin is detached. The total quantity of blood lost during the third stage, together with that expelled at the birth of the child, should not, in strictly normal conditions, exceed one pint.

FIG. 199.

Schultze's method of placental expulsion. (BUMM.)

After-Pains. After the expulsion of the placenta there is a pause of variable length in the uterine contractions. The contractions of this period are termed after-pains. They are not usually painful in primiparæ. In multiparæ they are frequently violent enough to cause considerable distress. Severe after-pains are due, as a rule, to the retention of blood-clots in the uterus. This occurs more frequently in women who have borne children, owing to the greater relaxation of the multipar-

ous uterus. In the presence of clots the uterine contractions become more powerful in the effort to expel them.

Retraction of the Uterus. Normally the after-pains serve a useful purpose. They bring about retraction, by which the active contractile portion of the uterus becomes shorter and thicker. The vessels, which are intimately interwoven with the muscular bundles, are thus securely ligated.

The peritoneal covering of the uterus accommodates itself to the diminished volume of the organ by reason of its elasticity. The uterine peritoneum presents no loose folds, as a rule, even after complete retraction.

Situation of the Uterus. On examination over the abdomen immediately after labor, the fundus is felt about half-way from pubes to umbilicus; normally it becomes as hard as a billiard ball during after-pains, relaxing only partially in the intervals.

Lower Uterine Segment. The lower uterine segment and the cervix remain passive for several hours after labor. The cervix presents a soft and almost shapeless mass scarcely distinguishable by the touch from the loose vaginal folds. Within a few hours the tonicity of its muscular structures begins to be reëstablished and the cervix to resume its usual shape.

CHAPTER IX.

THE MANAGEMENT OF NORMAL LABOR.

PREPARATORY TREATMENT.

No more important duties devolve upon the obstetrician than those pertaining to the observation and care of his patient in preparation for labor. The enforcement of hygienic rules, the regulation of the health and habits of the patient during pregnancy, is vital to the successful conduct of the obstetric case. Even minor departures from the normal course of gestation should receive the physician's attention and, as far as possible, be corrected. Especially should he acquaint himself in advance with the relative size of head and pelvis, with the presentation and position of the child, and, if possible, with all the facts in the individual case which may bear upon the issue of the labor.

Urinary Examinations. The excretory activity of the kidneys should be watched from the first. As a routine practice the urine should be examined once monthly or oftener during the first six months, and twice or more during the seventh. In the last two months of gestation systematic examinations should be made at least once weekly. The patient may be requested to report to her physician from time to time the daily quantity of urine. Autointoxication can seldom occur in a patient who is voiding sixty ounces or more daily. Something more is needed than merely testing for albumin. Albuminuria is not necessarily attended with marked toxæmia, nor is grave toxæmia in pregnant women always associated with albuminuria. Most essential are systematic quantitative determinations of the urinary solids. Especially significant is the daily excretion of urea. Though this particular solid is not a prominent factor in the toxæmia of pregnancy, the quantity of urea affords a fairly reliable index of the eliminative activity of the kidneys. It should not be forgotten, however, that the amount of urea and of the total urinary solids will vary with the character and quantity of food ingested and from other causes. The general condition of the patient should be taken into account as well as the urinary findings.

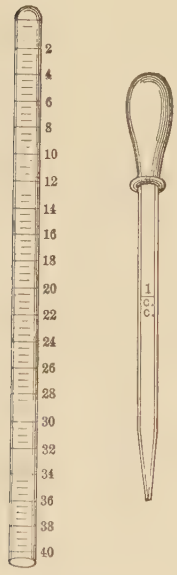
Tests for Albumin. For clinical use a good test for albumin is Esbach's. The reagent consists of picric acid, 10 grammes; citric acid, 20 grammes; water, 1000 grammes. The urine is mixed in a test-tube with an equal volume of the test solution, and the presence of precipitate noted after standing. Heat and nitric acid, nitric acid cold by the contact method, or Tanret's test, with suitable precautions, is a convenient and reliable test for albumin.

Urinary Solids. A ready method of computing the daily quantity of urinary solids is that of Haines, which is as follows: Multiply the last two figures in the number representing the specific gravity by the number of ounces of urine voided in twenty-four hours, and the resulting product by $1\frac{1}{10}$. This gives approximately the number of grains

of solid matter in the given volume of urine. The average amount of solids in health, it will be remembered, is 1000 grains.

Urea. For the estimation of urea the following method from Bartley's *Chemistry* may be employed: "A graduated tube (Fig. 200) is filled to the fifth division with a 20 per cent. aqueous solution of potassium bromide. Chlorinated soda solution (Squibb) is then added to the fifteenth or twentieth division. Pure water to the depth of one inch is now floated upon the contents of the tube. It is most easily deposited there with the aid of a pipette. (Fig. 201.) One c.c. of urine is then floated upon the water, taking care that the liquids do not mix. The open end of the tube is now quickly closed securely by pressing the thumb firmly upon it. The contents are mixed by gently shaking. When the effervescence has ceased, the reading is taken at the top of the liquid column, while the tube is held inverted. The end of the tube, still closed by the thumb, is now submerged in a large jar of water. The thumb is then removed, and the tube raised or lowered, till the surface of the liquid in the tube is at the same level with that in the jar, and the reading is again taken. The difference between the two readings is taken to represent the number of grains of urea in a fluidounce of the urine. This number multiplied by the number of fluidounces of urine voided in twenty-four hours is assumed to give in grains the total quantity of urea excreted during the day.

Fig. 200. Fig. 201.



Bartley's ureometer. Pipette.

Instead of the Bartley instrument the Doremus ureometer may be used as follows: With the stop-cock closed, the larger limb of the U-tube is filled with the sodium bromide and chlorinated soda solution in the same proportions as for the Bartley method. The smaller limb is then filled with the urine to be tested. By slightly turning the stop-cock, one c.c. of urine is allowed to mingle very slowly with the reagent in the larger limb of the tube. As the decomposition goes on the nitrogen accumulates in the upper end of the graduated larger limb. The volume of nitrogen is read off after effervescence has ceased. This represents the amount of nitrogen in 1 c.c. of urine. Each division of the graduated scale is supposed to indicate 0.001 gramme of urea. From this the total amount of urea for the day is computed.

Since the results by the foregoing methods of estimation are only approximate, corrections for temperature and atmospheric pressure may be neglected. The hypobromite process shows nearly the total nitrogen content, but the total urea unfortunately bears no constant relation to the total nitrogen.

Normally the average daily amount of urea varies from 20 to 30 grammes, 310 to 463 grains (Wood). The subject will be treated more fully under eclampsia.

The Nipples. Inquiry should be made with reference to the condition of the nipples. If they are small, depressed, or misshapen the

patient should be directed to draw them out daily with the thumb and fingers. The manipulation not only helps to develop the nipples, but it renders them less liable to injury by the child's mouth in nursing.

Inversion and other deformities of the nipples are often the result of pressure from tight clothing; for this the remedy is obvious.

The sebaceous secretion which accumulates upon the nipples affords a nidus for the growth of microörganisms, and uncleanliness is doubtless a prominent factor in infection of the nipples and resulting mastitis during lactation. Special attention should be paid to the cleanliness of these parts during the later months of pregnancy. A borax solution, one tablespoonful to the pint of water, is a good detergent. Bathing with this once daily is useful as a prophylactic against the occurrence of sore nipples during the nursing period.

The following method has served the writer well for the prevention of fissured nipples during lactation; every night in the last two months of pregnancy the patient anoints the nipples with lanolin, kneading them with the thumb and fingers. The hands must first have been cleansed carefully with soap and hot water. In the morning the nipples are cleansed by prolonged brushing with a soft brush and pure soap and water.

ANTEPARTAL EXAMINATION.

It is the duty of the obstetrician to inform himself before labor of the presentation and position of the child, the relative size of head and pelvis, and, as far as possible, of all the obstetric facts which may have to do with the result of the labor. This usually is done at about the end of the eighth month. The antepartal examination is conducted according to the following scheme:

A. Abdominal Examination.

Diagnosis of Presentation and Position of Fœtus.

Preparation. The patient lies in the horizontal position on a hard bed or table, the examiner standing or sitting at either side. The bladder and the rectum must be empty. The abdomen may be exposed or be covered with a thin sheet. If the sheet is used the examination is conducted through it or with the hands on the abdomen beneath it. The examiner first bathes his hands in warm water. This renders the tactile sense more acute and tends to prevent reflex contractions of the abdominal and uterine muscles which would be excited by contact of cold hands.

Location of Child's Back and the Small Parts. Three methods are available. One or all may be employed.

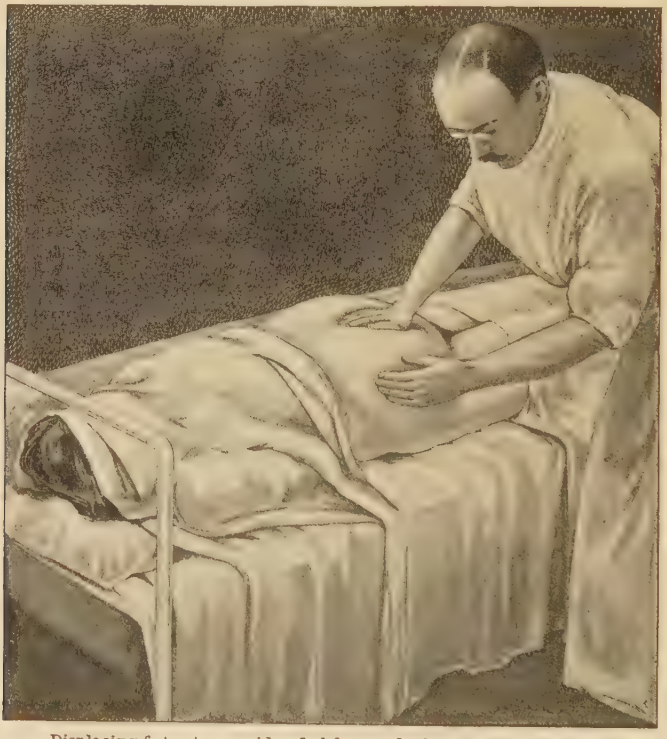
1. The child's back and the limbs or small parts usually may be made out by palpating systematically the entire surface of the abdominal tumor. Only the volar surfaces of the finger-tips are applied, and the touch should be light. The tactile sense is keenest with but moderate pressure. Deeper pressure is only occasionally necessary to make out the degree of resistance, the hardness, and the mobility of the fœtal parts beneath the fingers.

The small parts are felt as small nodules, knees, ankels, elbows, which glide about freely under the touch. They are identified by circling motions of the fingers with moderate pressure. Sometimes a fœtal extremity may be mapped out through the greater part of its length.

2. The fœtal dorsum is more readily palpated if the trunk is steadied by pressure in line with the long axis of the fœtus, the hand being held over the upper fœtal pole. This increases the convexity of the dorsal plane and brings it nearer to the examining hand.

3. Applying one hand flat on the middle section of the abdomen, moderately deep pressure displaces the fœtus to the side toward which its back lies and the liquor amnii to the opposite side. Still maintaining the

FIG. 202.



Displacing fœtus to one side of abdomen for locating dorsal plane.

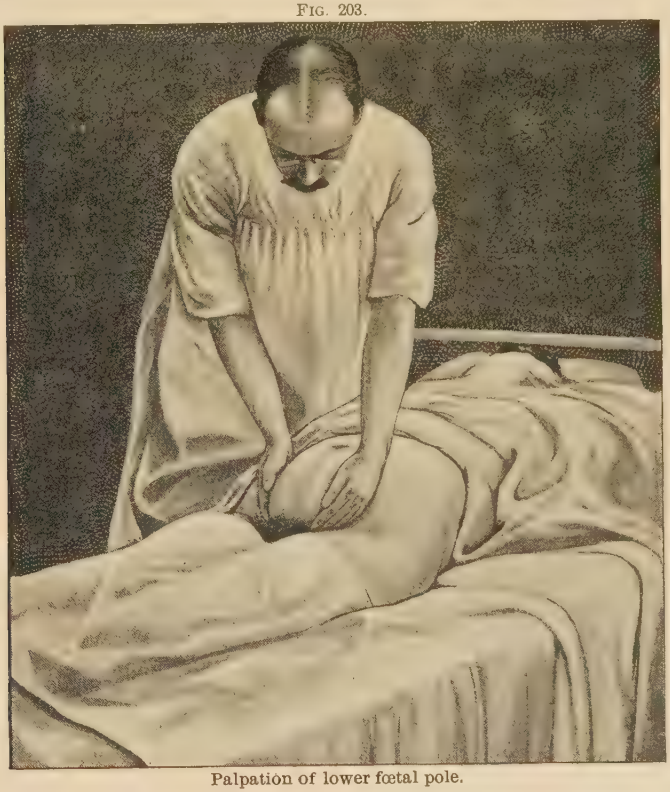
pressure, the hard body of the fœtus may be felt on one side of the abdomen and only fluid on the other side. (Fig. 202.)

By these simple manipulations it is usually possible to determine to which side of the mother the child's back lies.

To learn whether the back of the child is turned toward the back or front of the mother it will be necessary to distinguish the dorsal from the lateral plane of the fœtus. The back offers a broad resisting surface which is somewhat convex from end to end, and which runs off smoothly upon the head. The lateral plane of the fœtus is narrower; it is not convex from end to end, and a sulcus is felt between it and the head.

Except in twins where legs and arms usually can be felt in various directions, finding the small parts in one section of the abdomen confirms the location of the dorsum in the opposite region. Small parts to the right indicate a left, small parts to the left indicate a right position of the fœtus. Small parts few and hard to find suggest a dorso-anterior position of the child; small parts numerous and found near the middle section of the abdomen usually point to a dorso-posterior position of the fœtus. If small parts can be felt beyond either end of the fœtal ellipsoid, that end is pretty surely the breech.

FIG. 203.



Palpation of lower fœtal pole.

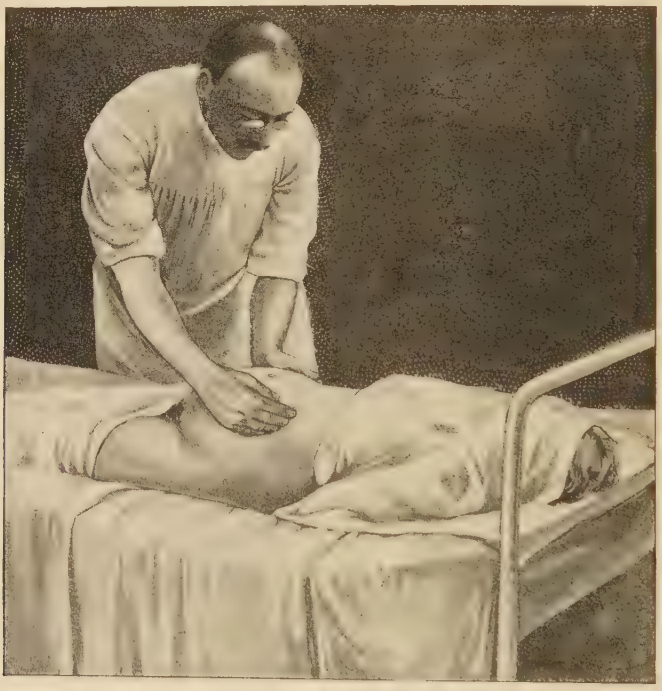
The examination, thus far, as a rule, present little difficulty. When the abdominal wall is over-fat or rigid, the uterus contracted, or tense from distension, as in hydramnios and certain other conditions, often the fœtal parts are more or less obscured.

Palpation of the Lower Fœtal Pole. The hands are placed over the lateral aspects of the lower abdomen with their palmar surfaces nearly facing each other, the finger-tips toward the mother's feet. The ends of the fingers should rest at first a little above Poupart's ligament. The hands are pressed downward toward the excavation, and backward toward the mother's back, till the lower fœtal pole is caught between them. (Fig. 203.) If not readily found the object may sometimes be

gained by moving the hands sharply from side to side, as if to toss the fœtal pole from one hand to the other, the hands meantime being brought nearer and nearer together.

The first object now is to find whether the fœtal pole under examination is the head or the breech. The two poles are distinguished by the following characteristics: The head is hard and globular, and it presents a sulcus laterally between itself and the trunk. Again, the head is the only fœtal part that sinks into the pelvic excavation before labor. In primigravidæ, as a rule, the head when it presents is found in the lesser pelvis during the last one or two months of pregnancy; in multigravidæ, owing to greater laxity of the abdominal walls, it lies above it till the period of lightening, and in two-thirds of the cases till labor begins.

Fig. 204.



Palpation of upper fœtal pole.

When, therefore, the presenting pole of the fœtus is found in the excavation before labor, that pole is the head. The breech alone is smaller, with the extremities larger, than the head. It lacks the hardness and the globular shape of the head; it presents no sulcus, and in all cases it lies above the excavation till labor is established.

The presence of the lower fœtal pole in one iliac fossa means a transverse presentation.

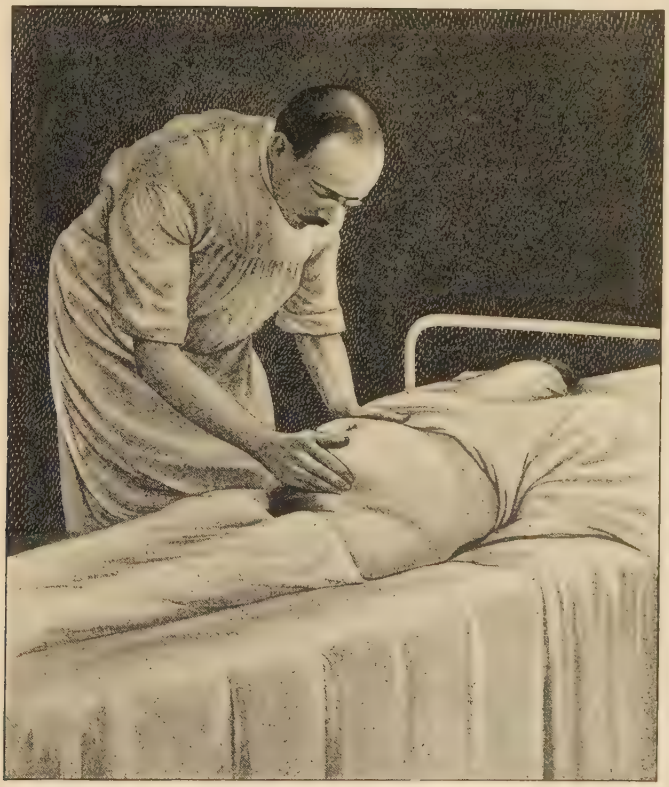
Palpation of the Upper Fœtal Pole. The hands are placed on the abdomen over the upper portion of the uterus with the finger-tips toward the mother's head, the volar surfaces of the hands nearly facing each other. (Fig. 204.) The upper fœtal pole is now palpated for the distinguishing

marks of the head and the breech. The poles are distinguished by the characters already given and by the fact that the head when in the upper uterine segment is susceptible of ballottement. The head can be tossed from side to side between the hands, or be made to bob under the fingers by light intermittent thrusts through the abdominal wall with one hand.

The breech lacks the flexible attachment to the trunk which marks the head, and it has little mobility not only because of this, but also by reason of the greater bulk of the component elements of the pelvic end of the fœtal ovoid.

Location of the Anterior Shoulder. The hands are held firmly upon the abdomen over the sides of the fœtal head and without relaxing the press-

FIG. 205.



Locating anterior shoulder.

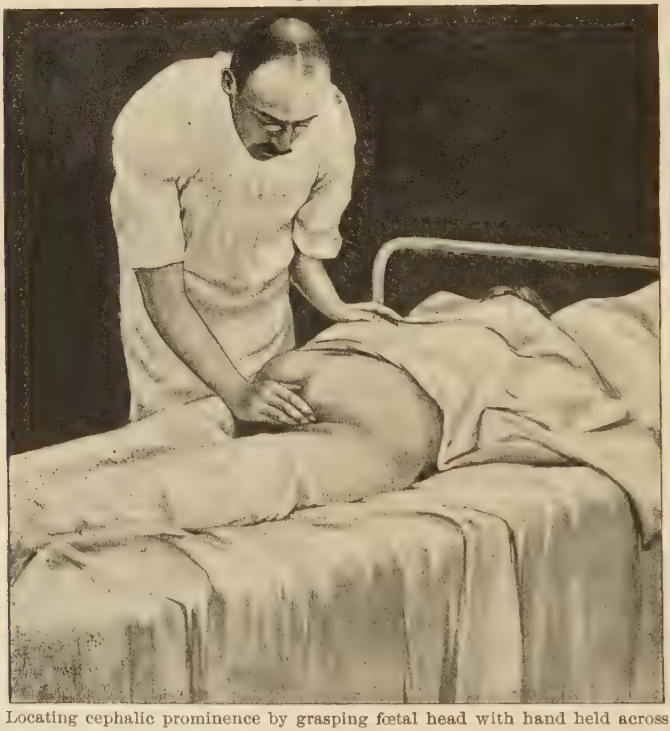
ure moved toward the trunk. The first obstacle encountered is the anterior shoulder. It is more surely identified by palpating it with one hand while the other steadies the fœtus by downward pressure upon the breech in the direction of the fœtal axis. (Fig. 205.) It presents a small rounded prominence immovably attached to the trunk. Sometimes its anatomical elements can be traced.

Finding the anterior shoulder on the left of the median line of the

abdomen in vertex presentation indicates a left, on the right a right position of the fœtus. Anterior shoulder within one or two inches of the median line indicates an anterior, several inches from the median line a posterior fœtal position.

Location of the Cephalic Prominence. When the head lies in the excavation in vertex presentation the occipital pole, owing to head flexion, sinks more deeply in the cavity than the sinciput. The latter lies at or just above the brim; therefore, the greatest cephalic prominence at the brim corresponds to the sinciput. It is located by laying the hand across the lower abdomen just above the symphysis and grasping the head (Figs. 206 and 207). The situation of the greater prominence may also be made out by palpation with both hands, as shown in Fig. 208. The hand on the side on which the occiput lies sinks more deeply into the excavation than the other. The prominence of the sinciput is naturally most marked in occipito-posterior positions.

FIG. 206.



Locating cephalic prominence by grasping fœtal head with hand held across the suprapubic region.

Location of the Fœtal Heart. Auscultation may be practiced with or without the stethoscope. The room must be still. For immediate auscultation, without the stethoscope, the abdomen is covered with a thin sheet or towel. Since a continuous solid medium helps conduction, the abdominal wall should be pressed firmly against the uterus. Downward pressure of the breech in the direction of the long axis of the fœtus facilitates the examination by thrusting the dorsum forward. The focus of auscul-

tation, the point at which the heart-tones can be heard loudest, as a rule, nearly overlies the lower angle of the left fœtal scapula.

FIG. 207.

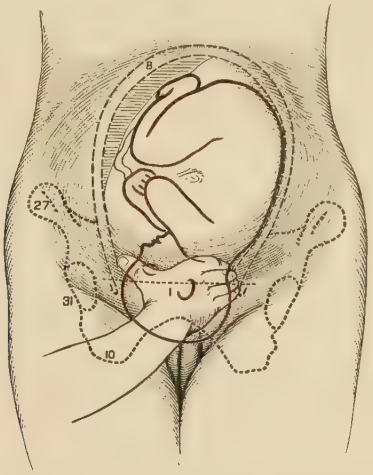


Diagram showing relation of hand to fœtal head in manipulation for locating cephalic prominence. (LEOPOLD and SAENGER.)

Fœtal heart on the left of the median line indicates a left, on the right, a right position of the fœtus. Fœtal heart near the median line

FIG. 208.

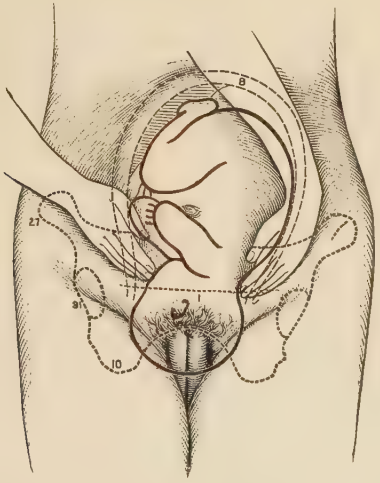


Diagram showing method of locating cephalic prominence by palpation with both hands. (LEOPOLD and SAENGER.)

points to an anterior, far away from it, to a posterior fœtal position. When the fœtal heart is above the unbilicus the presentation is generally

a breech, when below it, a vertex presentation. The location of the heart-tones, however, cannot be wholly relied on for the diagnosis of presentation. The heart lies nearly midway between the two extremities of the fœtal ellipsoid. Its height in the abdomen, therefore, is not materially affected by the presentation in multigravidæ in whom neither fœtal pole sinks into the excavation before labor. In primigravidæ, in whom the fœtus rests lower in vertex than in breech presentation, the location of the fœtal heart is of some value for the diagnosis of presentation.

Sometimes it happens that the focus of auscultation does not immediately overlie the heart. It may be found at some remote point in consequence of firmer contact of the fœtus with the uterine wall at that point. For a like reason a second focus may in rare instances be found.

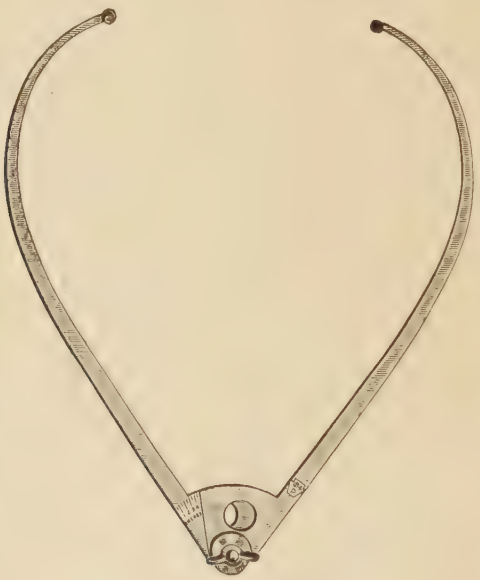
In dorso-posterior positions, in hydramnios, and in certain other condition the heart-sounds are not always audible.

Conclusions. A complete abdominal examination usually affords more reliable data for determining the fœtal presentation and position than does the internal examination. With rare exceptions a definite and positive diagnosis may easily be reached. Exceptionally the direction in which the occiput points may not correspond with that of the dorsal aspect of the trunk. The examiner should accustom himself to reserve his decision till the facts are all in hand, basing his conclusion upon the sum total of the findings.

Abnormal Conditions.

In course of the abdominal examination pathological conditions of

Fig. 209.

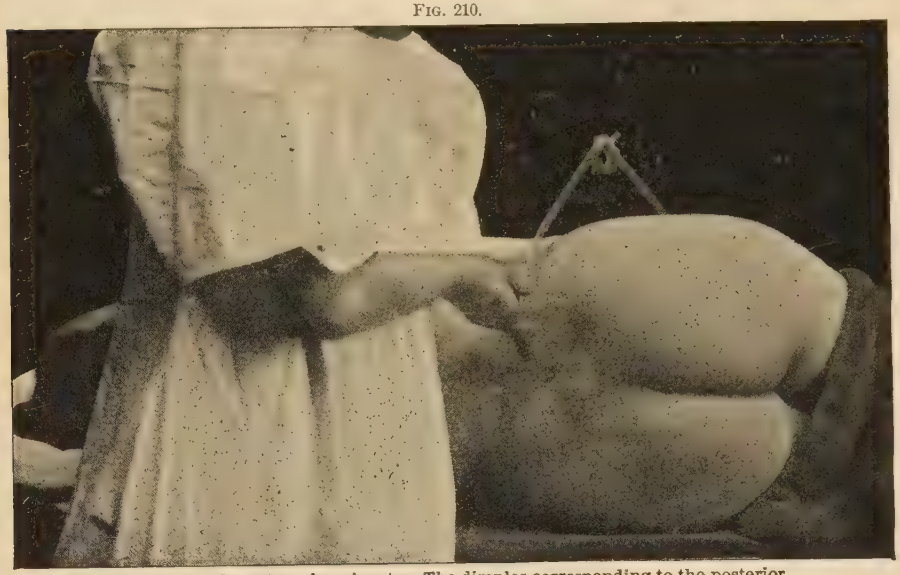


Collyer's pelvimeter.

maternal or fœtal origin that may complicate the labor are to be looked for. Morbid growths in the abdomen or pelvis may be detected by

palpation. The presence of hydramnios or of pendulous abdomen may be noted. Excessive size and persistent tension of the uterine tumor should suggest twins; usually a definite diagnosis is possible. Hydro-

FIG. 210.



Measuring the external conjugate. The dimples corresponding to the posterior superior spines of the ilium are shown in the figure.

cephalus should be recognized by palpation. It is more surely made out by measurements taken through the abdominal wall with calipers.

The location of the placenta when implanted anteriorly can sometimes be determined in the external examination. The convex margin can occasionally be felt as a resisting ring; within the placental area the fœtal

FIG. 211.

Measuring the intercristal diameter.

parts are obscure to the touch, while elsewhere they are easily detected. Thus the diagnosis of placenta prævia is sometimes possible by external palpation.

EXTERNAL PELVIMETRY.

In connection with the abdominal examination external measurements of the pelvis are to be made, except in cases in which there is ample

assurance from the character of previous labors that the pelvis is normal. Extreme contraction or marked asymmetry it readily recognized by palpation. Slight deformities are detected only by systematic measurement. For this purpose a suitable pelvimeter will be required. (Fig. 209.) Most essential are the antero-posterior diameter of the pelvis or the external conjugate, the interspinal, the intercristal, and the external oblique diameters. Of these the diameter of greatest practical value is the external conjugate.

The external conjugate is measured from the fossa just below the spine of the last lumbar vertebra to a point on the pubic surface just below the top of the symphysis. (Fig. 210.) To locate the last lumbar spine draw an imaginary line between the dimples corresponding to the posterior superior iliac spines. The second vertebral spine above this line is the last lumbar. The external conjugate diameter, or, as it is sometimes called, the diameter of Baudelocque, is nearly parallel with the plane of the brim and with the internal conjugate.

The method of measuring the intercristal diameter (Fig. 211) and the interspinal diameter is obvious. (See p. 170.)

The external measurements are fairly reliable as evidence of the shape and capacity of the pelvis internally. When all are small the pelvis is generally contracted. If the interspinal is equal to or greater than the intercristal diameter the pelvis is flattened. Inequality in the external oblique diameters is evidence of asymmetry.

To find the true conjugate from the diameter of Baudelocque, from 7 to 12.5 cm., $2\frac{3}{4}$ to 5 inches, must be deducted from the latter, according to the estimated thickness of the bones and the soft parts, the inclination of the symphysis, and the height of the sacral promontory.

Since it is impossible to know the exact allowance to be made in a given case, the external conjugate cannot wholly be relied on for detecting pelvic contraction. Yet it may safely be assumed that the pelvis is flattened when the diameter of Baudelocque falls below 16 cm., $6\frac{1}{4}$ inches, or that it is ample when the external conjugate exceeds 21 cm., $8\frac{1}{4}$ inches. As a general rule, contraction should be suspected when the external conjugate is less than 18 cm., 7 inches; the true conjugate is probably, though by no means surely, ample when the external conjugate is above 18 cm.

B. Vaginal Examination.

An internal exploration is advisable in all cases as a part of the preliminary examination; in women pregnant for the first time and in others whose obstetric history leads to suspicion of pelvic deformity, it is imperative. The objects are to learn the condition of the soft parts—vulva, vagina, cervix, especially in multigravidæ—to confirm the diagnosis of presentation and position, to detect a possible vicious insertion of the placenta, and to determine the capacity of the bony pelvis.

Antiseptic Preparation. The external genitals of the patient and the hands of the examiner should be prepared with the same care as for internal examinations during labor. For the technique of disinfection the reader is referred to page 228.

Examination of the Soft Parts. In multigravidæ the vulva, the vagina, and the cervix are first examined for injuries resulting from previous

deliveries. In all cases it should be noted whether pathological growths or congenital defects of the soft parts, which may complicate the labor, are present. A cephalic presentation, as a rule, may readily be made out, even before dilation of the cervix, by the touch through the uterine wall. A low implantation of the placenta in advance of the head should readily be detected.

Internal Pelvimetry. Most important is the examination of the bony pelvis. This should include the pelvic inclination, the configuration of the pelvis, the depth and inclination of the symphysis pubis, the shape of the sacrum, the height of the promontory, and the relative size of the head and pelvis. The pelvic diameters, especially at the inlet and the outlet, should definitely be determined.

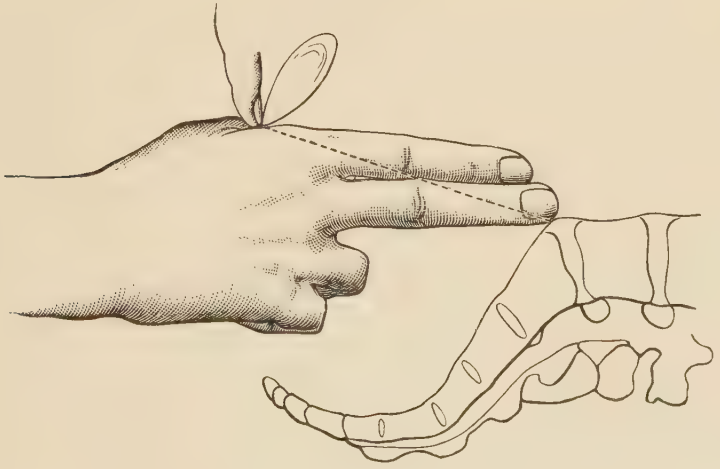
For internal pelvimetry the hand, as a rule, is the best instrument. The shape of the sacrum and the general capacity of the pelvis can be estimated approximately by palpation.

The Pubo-coccygeal Diameter is measured by placing the end of the second finger against the tip of the coccyx and bringing the radial edge of the outstretched hand in contact with the subpubic ligament. The point at which the latter rests against the hand is then marked by a finger of the other hand. On withdrawing the hand the distance between the two points of contact is measured with tape or calipers.

The Sacropubic Diameter is measured in like manner.

The Transverse Diameter at the outlet is best measured externally. With the patient in the lithotomy position the examiner places the thumbs upon the skin over the ischial tuberosities. The palmar surfaces of the thumbs are pressed firmly against the inner aspects of the tuberosities at the level of a line running through the anterior margin of the anus. The distance between the two points of contact is then measured by an assistant.

Fig. 212.



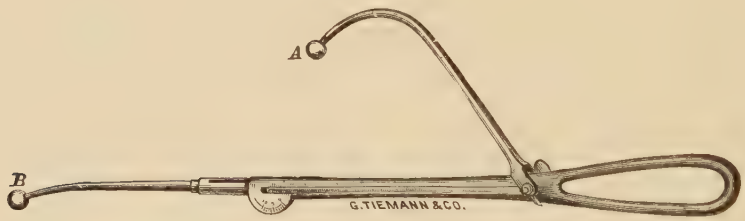
Manual method of measuring the diagonal conjugate.

The Diagonal Conjugate is measured as follows: With the patient in the lithotomy position two fingers of one hand are passed into the vagina. If the head is found resting deeply in the lesser pelvis in the

ninth month of pregnancy the relative capacity of the brim is assured and the measurement is unnecessary. Should only the occipital pole have sunk into the excavation it may be pushed up. The finger-tips are carried up and down over the region of the sacral promontory till the most prominent point is found. Against this the ulnar margin of the second finger-tip is held firmly. The radial edge of the hand is then raised till it rests against the subpubic ligament. The latter point of contact is marked by a finger-nail of the other hand. (Fig. 212.) On withdrawing the hand the distance between the two points of contact is measured as in the case of the pubo-coccygeal diameter.

The True Conjugate is computed from the diagonal, since the former cannot be measured directly. The diagonal conjugate corresponds nearly to the hypothenuse of a triangle of w. ' the base is the true conjugate. Generally the latter is obtained by subtracting from a half to three-fourths of an inch from the diagonal conjugate. The amount to be deducted, however, will vary with the depth and the thickness of the

Fig. 213.

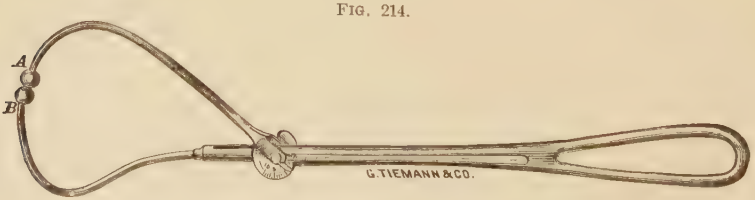


Hirst's pelvimeter adjusted for measuring from promontory to front of symphysis.

symphysis pubis, with its inclination, and with the height of the sacral promontory.

As these elements in the question are variable and their value in the individual case cannot be determined with accuracy, the estimation of the true conjugate by the foregoing plan is only approximate. A possi-

Fig. 214.



Pelvimeter adjusted for measuring thickness of symphysis.

ble error of at least a quarter of an inch must be assumed in all cases; frequently it is greater.

For more exact determination of the true conjugate Hirst, with an instrument of his own device, measures the distance from the promontory to the anterior aspect of the symphysis two-fifths of an inch below its upper margin. The thickness of the pubic joint is then measured

with the same instrument, and the difference between the two measures gives the precise value of the true conjugate.

Cephalometry.

Obviously the size of the fœtal head is a no less important factor in the labor than the dimensions of the maternal pelvis. Several methods have been practiced for estimating the principal diameters of the head *in utero*. Among the most satisfactory are the following:

Müller's Method. *Müller* determines the relative size of head and pelvis by trying whether the head can be crowded fully into the excavation by pressure applied over the base of the skull with the hands upon the abdomen. This is best done by an assistant while the examiner notes how far the head descends by one or two fingers passed per vaginam. The bladder and the rectum must first have been emptied. In skilled hands the Müller method is often useful for estimating the relation of the head to the pelvic brim.

Manual Measurement is practicable during labor after the cervix is sufficiently dilated. The patient should be under an anæsthetic and the bladder and rectum empty. With the hand passed into the uterus the relative size of head to pelvis may be made out with comparative accuracy. The internal hand should be gloved and the head pushed well down by the free hand applied externally over the abdomen or by the help of an assistant.

Stone's Method. Perret determined the occipito-frontal diameter of the head by direct measurement through the abdominal wall, using an instrument of his own device. Allowance was made for the estimated thickness of the abdominal wall.

Recently Perret's method has been simplified and improved by Stone of New York. The occipito-frontal diameter is measured as follows: The patient lies in the horizontal position. The hands of the examiner are placed upon the lower abdomen precisely as in palpating the lower fœtal pole in abdominal diagnosis. The head is caught between the hands, and the finger tips made to rest over the occiput and the sinciput respectively. The knobs of the pelvimeter are now placed against the abdomen on either side between the middle and the ring finger by an assistant. The latter position corresponds to the extremities of the occipito-frontal diameter. The knobs are pressed firmly against the abdomen and the reading taken. Owing to the extreme thinness of the abdominal wall near term, no allowance need be made for the thickness of the overlying maternal structures.

The biparietal diameter is computed from the occipito-frontal. In case of heads whose occipito-frontal diameter is less than 11 cm., the biparietal diameter is obtained by subtracting 2 cm. from the occipito-frontal. When the latter diameter exceeds 11 cm., 2.5 cm. is deducted. By Stone's method fairly accurate results are possible.

When the head has sunk too deep in the pelvis to be measured through the abdominal wall no measurement is required.

CASE RECORDS.

The habit of keeping systematic records conduces to thoroughness in the management of cases. Physicians in private practice, as in hospital work, should make use of printed forms for obstetric histories.

The following is a sample blank for obstetric records which may be modified to suit the requirements of individual practitioners:

OBSTETRIC RECORD.

Case of Application No.

Date of application 19

HISTORY.

Residence Nationality Married Single Widow

para Character of previous labors Puerperiums

Miscarriages

Last menses, date duration quantity

Quickening, date

ANTE-PARTAL EXAMINATION.

General. Date 19

General health

Heart

Lungs

Urine { Amount; Reaction; Specific gravity; Albumin; Sugar; Total solids; Urea; Casts; Other findings }

Breasts { Size; Veins; Areolæ; Nipples; Papillæ }

Abdominal.

Dorsum of fœtus, to mother's front back, right left

Fœtal head, where found size Fœtal movements

Anterior shoulder, where found Fœtal heart { Rate; Rhythm; Force; Location }

Height of fundus above symphysis

Liquor amnii, scanty normal excessive

Fœtus, one two Length of fœtal ovoid

External conjugate Interspinal diameter Intercristal diameter Obliques

Location of placenta Complicating tumors

Vaginal.

Condition of vulva, old injuries œdema rigidity

Vagina { Mucous membrane, healthy or not; Secretion, healthy or not; Other abnormalities }

Cervix { Position; Size; Softening; Old injuries }

Diagonal conjugate True conjugate Other diameters

LABOR.

Date 189

Stage of Dilation. Pains began frequency character

General condition of patient Temperature Pulse

Bladder, full or empty Rectum, full or empty Membranes ruptured or not

Presentation Position Posture

Fœtal heart { Rate; Rhythm; Force; Location }

Number of vaginal examinations

Complications and medication Duration

Stage of Expulsion. Pulse Temperature Character of pains

Fœtal heart { Rate / Rhythm / Force / Location } Vaginal secretion, free or scanty

Membranes ruptured, when how

Perineal stage, duration management

Number of vaginal examinations

Complications, medication, operations

Duration

Placental Stage.

Placenta, delivered at method

size shape seat anomalies

Membranes, complete or not how removed

Umbilical cord, insertion length anomalies

Uterus, retraction height of fundus shape

Injuries Medication

General condition of patient Pulse Temperature

Child, male female, alive dead, length weight

	OM	OF	SOB	BIP	BIT
Head { Diameters / Circumferences }					

Injuries

Congenital anomalies Rectum and urethra, pervious or not

Temperature in rectum shortly after birth

PUERPERIUM.

TEMPERATURE AND PULSE

Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Date														
Temp.														
C. F.														
41.1° 106°														
40.6 105														
40.0 104														
39.4 103														
38.9 102														
38.3 101														
37.7 100														
37.2 99														
36.7 98														
Pulse														
180														
170														
160														
150														
140														
130														
120														
110														
100														
90														
80														
70														
60														
50														
40														

Mother		Child	
		General condition	Temperature
		Eyes	
Diet	Breasts	Digestive organs: Mouth	
Bowels	Bladder	Digestive organs: Stomach	
Uterus	Lochia	Digestive organs: Bowels	
Treatment		Bladder	Umbilical wound
		Weekly gain in weight	

CONDITION ON DISMISSAL.

Date 19

General condition of mother
Uterus, size position shape
Cervix, size shape position injuries
Vulva and vagina, injuries
Child

Obstetric Armamentarium. Such instruments and drugs as are likely to be needed in the conduct of ordinary labor and in the more important emergencies of the lying-in room should be carried in the obstetric bag. The usual outfit comprises a pelvimeter, an obstetric forceps, a hypodermic syringe, an anæsthetic inhaler, a gravity or a Davidson syringe, a glass douche tube, a soft rubber catheter, a soft-rubber tube with bulb attached for clearing the child's pharynx in case of partial asphyxia, a hollow needle for hypodermoclysis, a Sims speculum, a double tenaculum, a straight uterine dressing forceps, two artery clamps, a curette about 14 inches in length, needle forceps, needles moderately curved and of assorted sizes, from 4 to 7 cm., or $1\frac{1}{2}$ to $2\frac{1}{2}$ inches, in length, for suturing lacerations, scissors, aseptic sutures of catgut, of silk and of silk-worm-gut in hermetically sealed bottles or glass tubes, a straight, blunt-pointed bistoury for episiotomy, green soap and two hand-brushes, a set of dilating water-bags, hard rubber tube for connecting bags with the Davidson syringe, a sealed package of sterilized strip-gauze, enough to fill the post-partum uterus, an instrument sterilizer in which all the instruments may be packed, and an operating suit.

The drugs most frequently needed are chloroform, ether, ergot, digitalis, veratrum viride, trinitrin, morphine, chloral, and, as antiseptics, mercuric chloride, iodide or cyanide. All except the anæsthetics may be had in tablet form.

A useful apparatus in forceps delivery in the absence of competent assistance is Buckmaster's or Robb's leg-holder for holding the thighs flexed on the abdomen. It is about three inches wide and two yards long, and is made of duck. At one end is a loop, which is slipped over one leg just below the knee. The band is carried over one shoulder, across the back, under the other shoulder, and fastened below the other knee. The band is so adjusted that it pulls from the outer side of the leg loop, abducting the knees. If made of thin material, the apparatus occupies but little room in the obstetric bag.

When a competent nurse has been engaged the preparation of sheets, towels, labor pads, abdominal binder, vulva dressings, gauze sponges, ligature for umbilical cord, utensils, etc., may be entrusted to her. They

should be sterilized and put up in aseptic packages in readiness for the labor.

In the large cities obstetric outfits may be had of commercial dealers by those able to pay for them.

Obstetric Antisepsis.

To an obstetrician, Ignatius P. Semmelweiss, belongs the credit of first putting into practice the principles of the present antiseptic system. In 1847, while an assistant in the Lying-in Department of the Vienna General Hospital, he was deeply impressed by the high mortality that prevailed in the service. This mortality he soon found was greatest in the students' clinic. Nearly 10 per cent. of the women delivered in that division of the service died. The students were engaged in the work of the dissecting-room and the dead-house at the same time that they were pursuing the course in practical obstetrics. In the midwives' clinic, on the other hand, the mortality seldom exceeded 3 per cent. Prolonged labor in the students' clinic was almost uniformly followed by death, while in the midwives' clinic the length of labor made little difference in the death-rate. Semmelweiss had also observed that women delivered before admission, and unattended, wholly escaped the fatal fever. While pursuing these observations one of his associates, Professor Kolletschka, died from a dissection wound. The similarity of his colleague's symptoms to those presented by the puerperal women dying of fever was apparent. It immediately dawned upon Semmelweis that the cause of the fatal malady in the lying-in service was the same as that which had resulted in the death of his colleague. Acting on this belief, he required the students to wash their hands in chlorine water before making internal examinations, and he restricted the number of such examinations. The death-rate immediately fell, and in little more than a year it had been reduced to less than 2 per cent. Thus was established the first step toward one of the most important of modern surgical discoveries.

Antiseptic Agents.

Mechanical Cleansing. Not the least important part of the antiseptic technique is the mechanical cleansing. This removes the greater part of the offending material. A well-polished instrument may be rendered almost sterile to culture tests by prolonged brushing with soap and hot water, and finally washing well with sterilized water. For the operation-field and for the hands and arms of the operator this part of the process is doubly necessary, since the removal of surface epithelium and sebaceous matter not only carries with it the major portion of the infectious material, but it is essential to the action of the chemical antiseptics. Freed from fatty matter and well wet by the soap-and-water scrubbing, the skin readily absorbs the antiseptic solution.

Heat is at once the most generally available and the most reliable germicide; either dry or moist heat may be used. Moist heat is much the more effective.

Dry Heat. Exposure for three hours to a temperature of 140° C. (284° F.) kills all pathogenic organisms and their spores. A special

apparatus may be employed or the oven of a cooking-range can be utilized. A thermometer capable of registering 148° C. (300° F.) or more must be used for regulating the temperature. Dressings, however, are penetrated by hot air only very slowly, and the method is, therefore, inadvisable for such material. It may serve for such utensils as are capable of withstanding prolonged baking without injury, but the length of time required renders it unsuitable for general use.

Moist Heat is employed in the form of steam and of boiling water.

Steam is effectual at a temperature of 100° C. (212° F.) when in motion. Superheated steam partakes of the disadvantages of hot air, and moist steam acts to the best advantage only as flowing steam. Exposure for thirty minutes to flowing steam at 100° C. is almost absolutely reliable. In institutions steam sterilizing is now generally practiced under a pressure of fifteen pounds, temperature 121° C., (250° F.) or more, by means of an autoclave. Special provision is made to secure penetration into dressings.

Numerous forms of steam sterilizers are to be had. An inexpensive apparatus which serves fairly well for the purpose is the Arnold steam sterilizer, or one of its modifications. Steam sterilizing is especially applicable for dressings and utensils.

Boiling for five minutes in water kills all pathogenic organisms likely to be encountered and their spores. One of the most effective of all practicable methods of using heat is boiling for five minutes in a 1 per cent. solution of sodium carbonate or bicarbonate. Articles so treated are sterilized in less time than in boiling water. Even the most resistant spores are destroyed in less than five minutes. The addition of the soda has the further advantage that it protects metallic instruments from tarnishing, and it removes fatty matter. For instruments it is desirable that the soda be chemically pure, since the impurities in the commercial article may tarnish polished steel surfaces. A fish-boiler or wash-boiler may be utilized in the absence of a special sterilizing apparatus. Boiling in the soda solution is the method now generally employed for sterilizing instruments. For convenience in handling, instruments are best deposited in a wire basket or in a folded towel during the boiling.

Chemical Antisepsis. Among the most useful chemical germicides may be mentioned the mercuric chloride, iodide or cyanide and carbolic acid. Creolin, lysol, and a multitude of other antiseptics more or less extensively used by obstetricians offer little or no special advantage. Chlorinated soda solution, peroxide of hydrogen, 3 per cent. solution, and iodine water 5 per cent. solution have the merit of being non-toxic.

Mercuric chloride is decomposed in the presence of alkalies or of albumin. In contact with the former the mercury is precipitated in the form of an oxide, and in the presence of the latter an albuminate of mercury is formed. A plain sublimate solution, therefore, soon becomes inert if mixed with bloody fluids. To prevent these changes, solutions of the bichloride of mercury for antiseptic use are acidulated with five parts of tartaric, acetic, or hydrochloric acid to one of the mercurial. The biniodide of mercury, on the other hand, yields a precipitate with albumin in acid, but not in neutral or alkaline solutions. The addition, of an equal weight of potassic iodide is required to render it freely

soluble. Cyanide of mercury does not tarnish metallic instruments and is comparatively non-irritating to the skin. These three mercuric salts are equally active as germicides, or nearly so, in solutions of equal strength. The strengths most commonly employed are from 1 : 5000 to 1 : 500.

The following formulas represent some of the antiseptic solutions used in obstetric practice :

Mercuric Chloride (Sublimate) Solution, 1 : 2000.

Bichloride of mercury	Gr. vijss.
Tartaric acid	Gr. xl.
Sterilized water	Oij.

Mercuric Iodide Solution, 1 : 2000.

Biniodide of mercury, Potassic iodide āā	Gr. vijss.
Sterilized water	Oij.

Mercuric Cyanide Solution, 1 : 2000.

Cyanide of mercury	Gr. vijss.
Sterilized water	Oij.

Chlorinated Soda Solution, 1 : 10.

Labarraque's solution	℥j.
Sterilized water	℥ix.

Carbolic Solution, 1 : 20.

Carbolic acid	℥j℈.
Glycerin	℥iij.
Sterilized water	ad. Oij.

Convenience and accuracy in the employment of the mercurial antiseptics are promoted by the use of tablets containing the required chemical ingredients.

The *peroxide of hydrogen* solution may be used plain or diluted with two to four volumes of sterilized water; *iodine-water* in 5 per cent. strength. The latter may be prepared by diluting tincture of iodine with water, adding enough potassium iodide to hold the iodine in solution.

Choice of Methods.

Since sterilization by exposure to the action of chemical solutions is uncertain and often imperfect, the latter should be reserved for purposes to which heat is not applicable. Their employment is limited almost wholly to skin disinfection.

Boiling, steaming, or even hot air may be used for utensils, or dressings which are not likely to be injured thereby.

At or just before the onset of labor the nurse should sterilize by steam a supply of sheets, towels, cheese-cloths for sponging, the vulvar dressings, and the ligature for the umbilical cord. They are first enveloped in a towel which is pinned securely, and in this they are kept after sterilizing till they are wanted for use.

Obstetric forceps, needle -forceps, needles, scissors, and such other instruments as may be required, are wrapped in like manner and boiled for five minutes in water or, better, in the soda solution.

The Obstetrician.

Of first importance is the asepsis of the hands. A hand-brush, soft soap, and a supply of the required chemical antiseptics are essential parts of the obstetrician's armamentarium. Soft soap may conveniently be carried in collapsible metal tubes. The chemical agents are carried in tablets or in the form of powders. The soap may be sterilized by heating to 100° C., and the hand-brushes by boiling in the soda solution. It is desirable that the hand-basin used for the soap and water cleansing, and those containing antiseptic solutions, be sterile.

Cleansing the Hands.

The hands and forearms are prepared by one of the following methods before contact with the genitals of the lying-in patient:

Fürbringer Method—Modified.

(*a*) The hands are brushed systematically for five minutes with soap and a hand-brush in several changes of hot water. The water is used as hot as can be borne. Special attention is given to the finger-tips, the sides of the fingers and the subungual spaces.

(*b*) The nails are then cleaned with a nail-cleaner and the hands again brushed for five minutes. The nail-cleaner should not be sharp, but should rather have moderately blunt edges, which may leave the surface of the nails smooth and polished. A piece of soft wood sharpened to a blunt point is a good substitute for the usual toilet article. It is made aseptic by boiling or steaming before using. The nails should constantly be kept short with their cut edges smoothed and polished, and the corners rounded.

After the soap-and-water cleansing the soap is removed by rinsing the hands in sterile water

(*c*) Finally, the hands and forearms are immersed for five minutes in a 1 : 2000 mercuric chloride, iodide, or cyanide solution.

It is a distinct gain to saturate the skin for a minute with alcohol before immersion in the antiseptic solution. The alcohol should be of 70 per cent. strength. This acts in some degree as a solvent for sebaceous material that may have escaped the soap-and-water cleansing, and it dehydrates the outer layer of the skin, thus permitting the antiseptic to sink more deeply.

Chlorinated Soda Method.

Steps (*a*) and (*b*) are the same as before.

(*c*) The hands and forearms are then covered with a paste made by wetting chlorinated lime with water. They are next rubbed with a lump of crystallized sodic carbonate (washing-soda) till a sensation of cold is felt. This yields chlorinated soda in its nascent state, which is the active disinfectant. Friction is now applied with a hand-brush for five minutes.

(*d*) The chemical is washed off with sterilized water and the skin surface is rinsed with alcohol or with weak ammonia water.

Hypochlorous Acid Method.

Steps (*a*) and (*b*) are carried out as in the foregoing methods :—

The hands are then immersed for five minutes in a hypochlorous acid solution prepared as follows :—

Dissolve one-half ounce of chlorinated lime (U. S. P.) in one quart of water, add one-half ounce of acetic acid (U. S. P.). The solution must be freshly prepared. Owing to its unpleasant odor it is best used in a room apart from the lying-in chamber.

By either process, the hands usually may be rendered practically sterile. Yet absolute disinfection of skin surfaces is impossible, especially after infection by virulent exposures.

Precautions.

After cleansing the hands care must constantly be observed to prevent reinfecting them. Contact of the hands with any object that is not aseptic must scrupulously be avoided. Frequent rinsing with the antiseptic solution is essential during attendance on the labor, since germs are constantly coming to the surface from the sweat-glands and hair-follicles where they had escaped the primary disinfection. Keeping the hands wet with glycerin containing a grain to the ounce of one of the usual mercurial salts favors continuous disinfection and helps to keep the skin soft. The glycerin should have been sterilized by heat.

Operating Suit. During actual attendance on the patient the obstetrician wears a freshly sterilized operating gown, or he may prefer a coat and trousers of white duck or linen, to be worn over his usual clothing.

Lubricants. For digital examinations within the passages no lubricant is required, as a rule. Generally it is sufficient that the fingers be wet with the antiseptic solution. Should any other lubrication be required, as, for example, when the hand is to be introduced within the vagina, the back of the hand may be smeared with glycerin or with vaseline which has been heated for ten minutes to 100° C.

Boiled Gloves. Should the physician be called upon to attend a labor directly after septic contact or when scant time is allowed for rigorous disinfection, he may wear rubber gloves which have been sterilized by boiling in water or in a solution of common salt. The soda solution is unsuitable, since it rapidly destroys the rubber. Lacking these, such manipulations as are required during the perineal stage of natural labor may safely be conducted through the intervention of an aseptic towel. In a considerable proportion of cases it is possible to manage the labor, if need be, without direct contact of the hands with the field of the obstetric wounds. The experiences of Kelly and of Zweifel have shown that no method of skin sterilizing can fully be trusted directly after exposure to virulent infection.

There is no kind of surgical work in which the routine use of rubber gloves finds a more appropriate application than in obstetrics. It is the writer's practice to wear them in practically all cases during attendance on labors. Since the gloves may be punctured or torn in use, the disinfection of the hands should be carried out as carefully as when gloves are not to be worn.

The Nurse.

It is scarcely necessary to say that the nurse must be no less careful in all particulars than the doctor is required to be in the observance of antiseptic details. Her clothing must be scrupulously clean, and she should wear wash-dresses. As an extra precaution she must refrain from attendance on obstetric patients for a week or more after a septic exposure. During that time her hands and forearms are to be sterilized repeatedly, and she should take two or three full baths, with special pains to cleanse the hair. In all cases the nurse makes an entire change of clothing on taking charge of a patient in labor.

The Patient.

The aseptic preparation of the obstetric patient should begin weeks before the labor. She is to be taught the importance of daily bathing and of strict cleanliness of the external genitals and the adjacent skin surfaces. Diseased condition of the rectum, the vulva, or the bladder should, as far as possible, be relieved. The character of the vaginal discharge should be learned in the antepartal examination. Discharges which are copious, which are yellowish or greenish, which excoriate the skin or are ill-odored, call for treatment of the diseased vagina and cervix. Douching twice daily for two or three weeks with a 1 : 5000 bichloride solution, or with a 2 per cent. lactic acid solution, is usually attended with marked improvement. The mercurial is to be followed immediately with a plain sterilized-water injection to prevent mercurial poisoning. It is advisable that all interference within the vagina cease at least three days before the labor, if possible.

In health the vaginal secretion of the pregnant woman is germicidal, and in normal conditions, therefore, no antepartal douching is permissible. Irrigation is not only useless, but by washing away the vaginal secretion and by impairing the secretory activity of the vaginal walls it disturbs the natural protective agencies against sepsis.

At the beginning of labor the nurse is instructed to give the patient a full sponge bath and a change of linen. A tub bath at this time is not advisable owing to the possible risk of infecting the vagina. The lower bowel is emptied by an enema and well washed out.

The external genitals and the entire lower half of the body are rendered aseptic. The technique is similar to that employed for cleansing the obstetrician's hands. The vulvar hair may be clipped short and finally a sterile compress saturated with a mild antiseptic, like boric acid or Thiersch's solution, or even a weak sublimate solution (1 : 5000), is applied over the vulva. This is worn during the first and second stages of labor. In hospital practice the lower extremities are enveloped in sterile coverings, and the table or bed on which the delivery takes place is dressed with steam-sterlized sheets.

The Lying-in Chamber.

If practicable a large well-ventilated room with a sunny exposure should be selected for the lying-in chamber. It is essential that the air be constantly renewed and be not exposed to contamination by reason of

defective plumbing, or other avoidable sources of impurity. An open fire in suitable weather aids in maintaining the supply of fresh air. The recent presence of septic disease in the room renders it obviously unsuitable. It is well to have the hangings cleansed and the entire room freed from accumulated dust a few days before the labor. It is not necessary that the room be stripped of its usual furnishings, provided they are clean. One or two small tables for holding instruments, sterilizing-basins, hand-brushes, etc., should be available. Should an operating-table be required in case of artificial delivery, the usual kitchen-table is suitable.

Nurse's Preparations. The nurse has ready, in advance of the labor, a dozen towels and a half-dozen or more bed-sheets, two rubber sheets, large enough to cover the entire width and the greater part of the length of the bed. A labor pad, consisting of a square sack of cheese-cloth filled with surgical cotton or other absorbent material, should be provided. It is to be placed under the patient during labor as a convenient dressing for taking up the discharges. This is made three or four inches thick and three feet square. Instead of this, a Kelly rubber pad, such as is commonly used in gynecological work, may be employed. Two dozen lochial guards should be prepared. They are made of the same material as the labor pad, and about two inches thick, four inches wide, and ten inches long. Tail-pieces are attached at each end for fastening to the abdominal binder. In the absence of these, folded napkins may be used as vulvar dressings. Scissors for dividing, and narrow linen bobbin or other suitable material for ligating, the cord are provided. All these things are wrapped in several packages, sterilized, and not opened till required for use. The nurse also has ready a hand-basin with soap and water, another for the antiseptic solution, two new hand-brushes, and glycerin or vaseline as a lubricant. These, too, must be sterile.

In hospital practice the patient's linen and the bed linen are steam sterilized at the beginning of labor. Similar precautions are to be enforced as far as practicable in home confinements. Frequently in the latter class of cases it must suffice that the linen be fresh laundered. When complete asepsis is impracticable the nearest approach to it that may be possible under the circumstances is imperative. The nurse should be provided with antiseptics for use during the puerperium.

Preparation of the Bed. In family practice the patient is usually confined on a bed, or a separate cot is provided, the woman being transferred to the bed at the close of labor. In hospitals a table is employed for artificial deliveries, and this should be the rule in private practice. To protect the bed from soiling by the discharges, it is covered with a rubber sheet. Over this is spread a muslin sheet, and both are pinned fast to the mattress. A second rubber sheet may be spread over these, and that overlaid with a muslin sheet. The latter are removed at the close of labor, and the remaining rubber sheet after five or six days. When economy requires, table oilcloth may be substituted for the rubber.

For convenience the cot or bed should be so placed as to be easily accessible from both sides.

MANAGEMENT OF THE FIRST STAGE OF LABOR.

Examination During Labor.

Preparation of the Patient. The antiseptic preparation of the patient has already been considered. At the onset of labor the lower bowel is to be cleared and well washed out with an enema. If the first stage is prolonged the rectal injection may be once or twice repeated. Until the second stage begins the woman, as a rule, need not be confined to the bed. The progress of labor is promoted by the upright position. Yet too much walking may be inadvisable before the head engages in the pelvic brim. It may favor prolapse of an arm or the cord.

Diagnostic Signs of Beginning Labor. Precursory signs of labor are frequently observed for ten days or two weeks before active pains begin. First to attract the attention of the patient is the lightening. This generally precedes the labor by ten days or a little more. The uterus sinks more deeply in the pelvis and the waist line becomes smaller. Lightening, however, is not constant. At the same time the pressure of the uterus on the pelvic viscera is increased, and bowel movements and evacuations of the bladder occur more frequently.

Irritability of the bladder and the rectum becomes still more marked when labor begins.

The vaginal secretion grows freer as labor is established, and the mucous plug is expelled from the cervix in the form of a gelatinous mass.

A slight discharge of blood or of blood-stained mucus, the *show*, may be observed. Yet the show and the expulsion of the mucous plug are not always noted.

Inquiry should be made with reference to the frequency, strength, and duration of the pains and the time when they began.

Most significant of actual labor are rhythmic uterine pains, with evidence of uterine contraction during the pains as elicited with the hand on the abdomen over the uterus.

Abdominal Examination. The general plan and method of the abdominal examination during labor are substantially the same as in the antepartal examination.

The size of the fetal head should be estimated as accurately as possible by palpation, or by measurement with the pelvimeter through the abdominal wall and by observing how far it sinks into the pelvic brim or may be made to do so by suprapubic pressure.

The stage of progress may be determined approximately in the abdominal examination by noting how deeply the head has sunk into the true pelvis. When the head has not yet engaged, if the membranes are still unbroken, it may usually be pressed up out of the excavation by placing the hands on the abdomen over the sides of the head and sinking the finger-tips into the pelvic brim. After engagement of the head the relation of the base of the skull to the pelvic inlet is made out by deep palpation above the pubes. The height of the anterior shoulder, too, is learned by palpation, and it helps in deciding how far the head has descended.

The signs of a possible face presentation should be looked for in the

abdominal examination during labor. The extension of the head which causes the face to present, develops almost invariably only after the pains begin.

The rate and force of the fœtal heart are to be noted and to be listened for at intervals throughout the labor. A fœtal pulse below 120 or above 150 to the minute is a probable indication of danger to the child.

A distended bladder presents a tense fluid tumor between the uterus and the lower part of the abdominal wall. It is readily recognized by palpation over the suprapubic region.

FIG. 215.

Vaginal examination. Introduction of examining finger. (BUMM.)

Vaginal Examination. Before examining internally the hands must be disinfected. This part of the examination aims to determine the condition of the vulva, the vagina, the cervix, and the bony pelvis, and to verify the diagnosis of fœtal presentation and position as made out by the abdominal examination. Possible anomalies of the fœtus, too, that may complicate the labor should be recognized.

The resistance likely to be offered at the vulva as the head descends, the lubrication of the vagina, the degree of dilation of the cervix, the thickness and consistence of the cervical border, the presence or absence of injuries sustained in former labors are to be noted.

For the internal examination the patient lies on the back with the knees drawn up. The examiner separates the labia with the thumb and fingers of one hand and introduces the examining finger or fingers of the other hand into the vagina with care to prevent contact with surfaces below the hymeneal orifice.

Vertex presentation is recognized by the hard and globular character of the cranial portion of the fœtal head and by the presence of sutures and fontanelles.

The position is made out by locating the sagittal suture and learning which end is forward, or by finding in which quadrant of the pelvis the smaller fontanelle lies. It is not always easily practicable to reach the large fontanelle. Great care is required to identify the anatomical landmarks of the presenting part, especially when they are obscured by œdematous swelling. Every accessible part of the presenting pole should be searched with the examining fingers, using firm pressure. For the diagnostic signs of other than vertex presentation the reader is referred to the chapters treating of those presentations.

Prognosis. Definite predictions as to the duration of the labor are seldom possible. Conditions which determine the prognosis are the relative size of head and pelvis, the hardness of the head, the degree of descent, the thinness and softness of the cervix, the presence or absence of complications, and the strength and efficiency of the pains. But it is impossible to foretell with certainty the character of the pains. Yet the patient is entitled to such assurance and encouragement as can reasonably be given.

Patient to Remain out of Bed. As a rule, the patient should not be confined to bed during the first stage. She is usually allowed the liberty of the room. Much walking may hinder the engagement of the head, and is not advisable before the head has sunk into the excavation. A slow labor will be accelerated by moving about and even by the standing or sitting position; in over-rapid labor the woman should maintain a reclining posture on the bed or couch. The course to be pursued must be determined by the circumstances of the individual case.

Frequency of Vaginal Examinations. A surgically clean internal examination entails little or no risk of infection. Yet abundant statistics have shown that the best puerperal results are obtained when it is possible to refrain wholly from internal interference. All unnecessary manipulations within the passages should be avoided. If a thorough antepartal examination has been made, a single vaginal examination during the first stage of labor will usually suffice. This is generally advisable, to make sure that the cord or an arm has not prolapsed and that no other complication has developed. Should any irregularity be detected repeated examinations may be required.

General Rules. In the absence of complications the attendance of the physician during the first stage of labor is not required, except in so far as is necessary to keep advised of the rate of progress. Except in very slow labor the physician should be present in the house from the time the dilation of the cervix is nearly complete. Unnecessary manipulation of the cervix is especially to be avoided. It impairs the local resistance against infection. Lifting the anterior portion of the cervix over

PLATE XVIII.

Walcher's Position.

the occiput is permissible only when the anterior lip retards abnormally the progress of labor. Light food may be allowed during the first stage. Pain, if severe, may be relieved by chloral. From 45 to 60 grains may be given in doses of 15 grains every fifteen minutes in plenty of water.

Management of the Second Stage of Labor.

The management of physiological labor in the second stage, as in the first, should mainly be expectant. So long as all is normal the rôle of the obstetrician is little more than that of a passive observer.

From the time the second stage is about to begin the patient must be in bed, and she must not, as a rule, be permitted to leave it even for evacuations of the bladder or the bowels. She is to be dressed in her usual night clothing, which is turned up and pinned at the shoulders to protect it from soiling. For still further protection of the patient's linen, the lower half of the body may be covered with a folded sheet fastened at the waist like a skirt.

A slow labor may be accelerated or an over-rapid labor retarded, when possible by resort to simple measures. Inefficient pains are to be reinforced by summoning the aid of the abdominal muscles. Encourage the patient to hold the breath and bear down as the pain reaches its height. She may now and then assume a sitting posture on the edge of the bed. Bracing the feet and pulling upon the hands of a bystander or on a sheet-sling help the expulsive efforts. The sling is made by folding a sheet at diagonally opposite corners and twisting it loosely into a rope. One end is fastened at the foot of the bed and the patient pulls at the other. Sometimes a moderately firm abdominal binder may be useful.

In too rapid labor the foregoing measures must be withheld and the pains retarded if necessary by the use of chloroform.

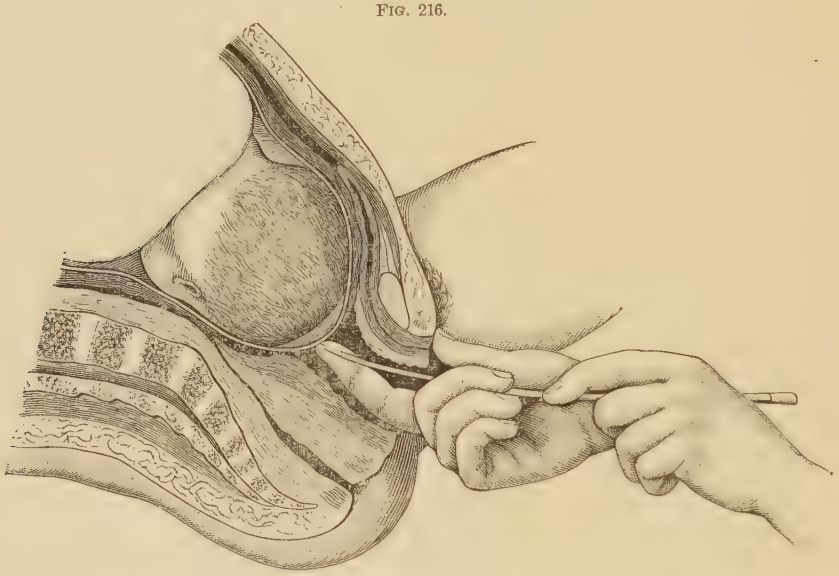
Obstetric Positions. The choice of position in the expulsive stage of labor is usually left to the patient. Her comfort is promoted and the pains are stimulated by occasional changes of posture. For internal examinations either the lateral or the dorsal position may be chosen. The latter generally is preferred. A semi-recumbent or a sitting posture favors the pains owing to the influence of gravity.

Walcher's Position. By reason of the nutation of the sacrum the antero-posterior diameters of the pelvic inlet are slightly increased when the woman lies on the back with the thighs hanging in extreme extension over the edge of the bed or table. (Plate XVIII.) The maximum possible gain in the conjugate with this posture is 13 mm. Advantage may be taken of this fact while the head is passing the brim, especially in difficult labor. At the outlet of the pelvis, on the other hand, the sacro-pubic diameter is similarly increased when the thighs are strongly flexed on the abdomen. For this reason, as well as for convenience in managing the birth of the head, the lateral position with the knees drawn well up is usually to be preferred from the time the head approaches the pelvic outlet.

Vaginal Examinations. In strictly normal labor there is little occasion to examine internally after the second stage is established, except for

observing the rate of progress. With practice even the degree of descent may be learned almost as surely and as readily by external palpation, and vaginal examination may, in simple labor, be omitted. By palpa-

FIG. 216.



Instrumental puncture of the membranes. (RIBEMONT-DESSAIGNES and LEPAGE.)

ting over the suprapubic region the head can be made out till it has sunk deeply in the excavation. The occiput from the time it has reached the outlet of the bony pelvis can be felt by deep pressure with one or two fingers applied externally over the pelvic floor. While there is practically no danger of infection in the vaginal examination conducted under proper aseptic precautions, yet the best puerperal results, as already stated, are attained when no internal manipulation is practised. Should the labor be unduly prolonged or be otherwise abnormal, repeated internal examinations may be required to determine the cause.

Rupture of the Membranes. The bag of membranes usually breaks spontaneously by the time dilation is complete, frequently earlier. Sometimes it gives way at the onset of labor. In normal labor after the protruding bag has reached the pelvic floor, it no longer serves any useful purpose. If it still persists it should be ruptured artificially. Usually this may be done with the finger-nail while the sac of waters is tense during a pain. This failing, a sharp-pointed scissors, a straightened hairpin, or other instrumental perforator, may be used. The instrument is sterilized and passed with its point resting on the finger-tip as a guard and guide (Fig. 216.) A mere prick suffices, the membranes tearing readily when once punctured.

Obstetric Anæsthesia. In obstetric as distinguished from surgical anæsthesia, the object is to blunt, not wholly to abolish the sensibilities. The use of anæsthetics for this purpose in labor is justified on both humanitarian and scientific grounds. It is not only the plain duty of the obstet-

rician to relieve the needless sufferings of his patient, but the judicious employment of anæsthetic agents spares her unnecessary exhaustion. It must not be forgotten, however, that the prolonged or too free use of anæsthetics is capable of harm. When pushed beyond the stage of mere analgesia they lessen the strength and frequency of the uterine contractions. While seldom causing death, they are not infrequently contributing factors in the fatal issue. Doubtless the abuse of anæsthetics may be a predisposing cause of sepsis, by favoring relaxation of the uterus and by impairing the resisting powers. They should be withheld so long as the pains are well borne without them. They are more especially called for in the latter part of the expulsive stage of labor. At the acme of expulsion the anæsthetic should, as a rule, be pushed nearly or quite to the surgical degree.

Choice of Anæsthetics. For mere obstetric analgesia chloroform generally is preferred. It has the advantage over ether that it is pleasanter; the necessary quantity, too, is less bulky, and, consequently, is more conveniently carried in the obstetric bag. On the other hand, it is not so safe as ether, and possibly it impairs the strength of the uterine contractions more than does the latter agent. It is a powerful vasomotor depressant and its too free use may paralyze the arteries and incapacitate the heart. Theoretically it is especially dangerous in the third stage of labor.

For obstetric operations in which full narcosis is required, chloroform, as a rule, gives place to ether. By some obstetricians the latter anæsthetic is preferred for general obstetric use. It is no less manageable than chloroform for all obstetric purposes, and, as its advocates believe, it does not weaken, but rather stimulates, the uterine contractions.

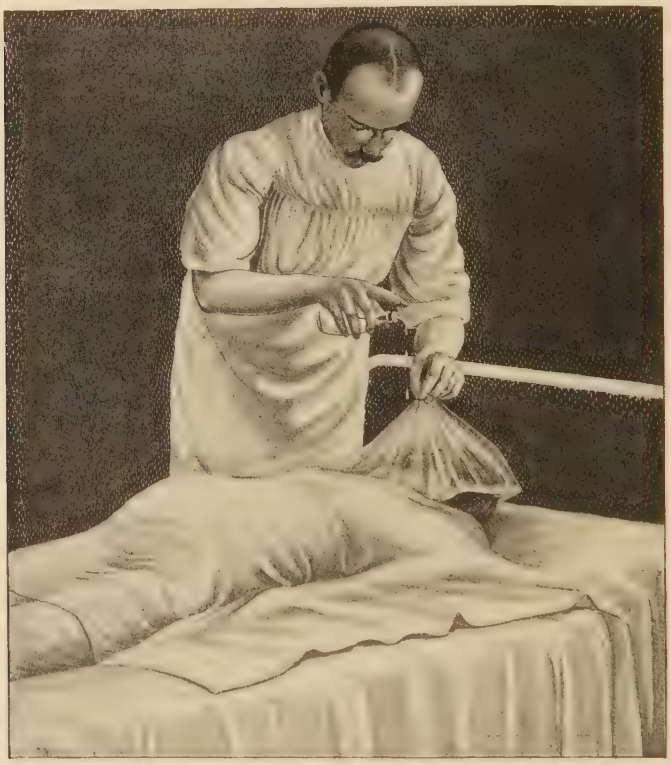
In the presence of bronchitis ether is unsuitable, owing to its irritant effect on the respiratory mucous membranes. In atheromatous disease it is dangerous, since it increases the vascular tension. Chloroform is to be preferred in eclampsia and in tetanic contraction of the uterus.

Method of Administration. In obstetric anæsthesia the anæsthetic may safely be given by a competent nurse under direction of the physician. Narcosis to the surgical degree for operative intervention should be trusted only to a skilled medical assistant. It is desirable that the patient shall have taken no solid food for several hours before anæsthesia, especially if the narcosis is to be carried to the surgical degree. The head is lowered to the level of the body, if chloroform is to be given, all constricting bands of clothing are loosened, and the region of the mouth and nose smeared with glycerin. The latter precaution is required to prevent injury to the skin by contact of liquid chloroform or of its concentrated vapor. The patient is requested to remove false teeth or other foreign bodies from the mouth. The heart is examined; yet the presence of cardiac disease does not necessarily forbid the use of anæsthetics. Usually the shock of difficult labor, and especially of operative interference, is more dangerous without than with the anæsthetic. Yet a weak heart calls for special caution in the use of these agents.

For ordinary obstetric anæsthesia a coarse towel is a good inhaler. It is placed over the patient's face and held by the middle, which is lifted six or seven inches from the face. (Fig. 217.) A large cone-shaped air-chamber is thus formed which insures ample

dilution of the anæsthetic vapor. Instead of this an Esmarch mask or an Allis inhaler may be used. The anæsthetic is dropped upon the inhaler opposite the patient's mouth and nose. Except when complete narcosis is desired it is given only with the pains. To develop its effect by the time it is most needed, when the pain has reached its height, the inhalation must begin promptly at the beginning of the pain. If chloroform is used only a single drop is let fall on the inhaler with each breath. If ether is employed three or four drops will be required at

FIG. 217.



Giving chloroform with the towel-inhaler and dropping-bottle.

each inspiration. To increase the effect of either drug, if necessary, ask the patient to breathe rapidly as the inhalation begins. The administration is stopped by removing the inhaler as soon as the pain is about to subside. The drop-by-drop method should be insisted upon for either obstetric or surgical anæsthesia. It insures at once the greatest possible safety and the least discomfort in the use of either chloroform or ether.

At the acme of expulsion, as the head is passing the introitus, the anæsthesia should generally be pushed to full unconsciousness. This not only spares the woman the severer pangs of labor, but by retarding expulsion and by relaxing the muscular structures of the pelvic floor it lessens the risk of lacerations at the vaginal outlet.

Complete anæsthesia when required for obstetric operations during

the birth of the child or the third stage of labor is to be managed in accordance with the well-established rules of surgical practice.

Intraspinal Cocainization. The injection of cocaine into the spinal canal has been practiced by Kreis, of Germany, Marx, of New York, and others, for obstetric analgesia, but the method has deservedly fallen into disuse.

The Perineal Stage of Labor. The management of labor at the acme of expulsion is chiefly concerned with the prevention of injuries to the pelvic floor. Normally the soft parts at the vulvo-vaginal outlet of the birth-canal yield without tearing under the gradual advance of the fœtal head and escape important injury. Yet notable laceration of the pelvic floor occurs in about 35 per cent. of term labors in primiparæ, and nearly a third as often in women who have been delivered before. Rupture of the fourchette is the rule, and is unimportant. Minor tears may occur at any part of the vulvo-vaginal ring. The more important lesions are those of the posterior segment of the pelvic floor near the median line especially those involving one or both vaginal sulci, or the sphincter ani muscles.

More or less extensive laceration is frequently unavoidable in fœtal malposition, in narrow pelvis, in relatively small vaginal outlet, and in undue rigidity of the pelvic floor from defective development, œdema, or other causes. On the other hand, at least half the pelvic-floor injuries occurring in general obstetric practice are preventable by skilful management of the perineal stage of labor.

Prevention depends on the distensibility of the pelvic floor and the smallness of the engaging circumference of the fœtal head.

The relaxation of the floor is promoted by slow and gradual delivery of the head, permitting the structures to stretch. Over-rapid expulsion frequently results in laceration. It is seldom that the head can safely be permitted to escape in first labors in less than twenty to forty minutes from the time the pelvic floor begins to bulge. Half this time may suffice in subsequent labors.

The mechanism of expulsion must be so regulated that the smallest circumference of the head is kept constantly in the grasp of the resisting girdle. Moreover, the direction of expulsion must be controlled lest the soft parts be subjected to too great strain by misdirection of the driving force.

From the time the head approaches the pelvic floor the labor is best managed with the patient lying on the side, especially in primiparæ. The hips are brought close to the edge of the bed. The obstetrician standing or sitting by the side of the bed has complete command of the rate and mechanism of expulsion. For some time before the occiput appears at the vulvar orifice the head can be felt without examining internally by pressing the fingers against the pelvic floor. The rapidity of descent may thus be watched till the occiput begins to protrude during the pains.

From this period, if not for a longer time, the parts should be under ocular inspection. The rate of descent is moderated by moderating the action of the abdominal muscles by the use of chloroform, and by direct pressure with the fingers held against the uncovered portion of the head. The head is permitted to descend only so far at each pain as can be done without exposing the tense structures to risk of tearing. The degree of tension is estimated by occasionally passing the finger just within the resisting vulvar ring at the height of a pain.

To secure delivery by the smallest circumference of the head too rapid extension must be prevented. Keep its long axis in the axis of the outlet till the equator of the head has passed. To relieve the pelvic floor from undue strain by misdirection of the expelling force, press the head firmly up into the subpubic arch as it is about to escape.

FIG. 218.

Regulating birth of head.

All this may be effected without pressure upon the pelvic floor. Yet no harm need be done by properly guarded pressure against the head through the floor. With the thumb laid along one side of the vulva and the fingers along the other, and the palm of the hand resting broadly over the perineum, the head can be carried well up into the subpubic space and the rate and mechanism of delivery readily be controlled. The object of this manœuvre, however, is not support of the floor, but regulation of the head movements.

For the execution of any of the foregoing manipulations the operator may assume the position shown in Fig. 218 during the expulsion of the head. Sitting on the bed behind the patient, two or three fingers of each hand are held upon the head, or one hand is placed on the head and the other on the part of the pelvic floor which overlies the head.

A basin containing the antiseptic solution should be placed near the bed. With a piece of sterile cheese-cloth freshly wet with the antiseptic solution, the protruding portion of the head and the surrounding perineal surfaces are cleansed as often as soiled by the discharges. To protect the hands from soiling with fecal matter it is well to keep the anal orifice covered with an aseptic towel saturated with the antiseptic solution during the manipulations required at the expulsion of the head.

Episiotomy. When extensive laceration at the vaginal outlet is otherwise inevitable incisions may be made on either side. Episiotomy substitutes for a posterior laceration, which is often difficult of complete repair, incisions through less important structures, which can easily and perfectly be closed by suture. The incisions are made about one-third way from the median line posteriorly when the parts are stretched during a pain. They should be about 6 mm., $\frac{1}{4}$ inch, deep, and 2.5 cm., 1 inch, in length.

It is needless to say that to be of service the episiotomy cuts must anticipate the tearing, yet the necessity for them cannot be determined, nor can they be effected properly till the parts are well stretched by the protruding head.

During a pain a finger is passed within the vulva by the side of the head till a cord-like girdle is felt. A blunt-pointed bistoury is then slipped flatwise between the head and the tense ring. Holding it in a line parallel with the long axis of the mother's body the edge is turned outward and the girdle is cut. The incision is repeated on the opposite side of the vulvo-vaginal orifice. Should the mistake be made of holding the knife in the direction of the outlet of the soft parts, instead of the long axis of the mother's body, it will be found after delivery that the tip of the blade has invaded the part of the pelvic floor which the operation was intended to save. A strong blunt-pointed scissors may be substituted for the bistoury if preferred.

After delivery the incisions are sutured. This is easily effected with the patient on the back, or, better, on the side. In the latter posture the uppermost cut is sutured first. The field is thus unobscured by blood which drains from the vagina over the dependent side. The position is then reversed for closing the other incision.

Management of the Birth of the Trunk. On birth of the head examination is promptly made to learn if the cord is coiled about the neck. If it is, the loop or loops are drawn down successively over the head. Should the attempt fail, which can scarcely be possible, the cord is divided with scissors and the trunk at once extracted. The head is supported with the hand, in the axis of expulsion. The delivery of the trunk is left to the natural forces unless reason appears for hastening the extraction. It is not advisable to drag the child unnecessarily from the uterus in the interval between contractions. As a pain comes on a finger is hooked in the posterior axilla from behind. The shoulder is pressed forward toward the child's sternum and is lifted over the perineal edge while the anterior shoulder still rests behind the symphysis. The posterior arm is now extracted and the remaining shoulder escapes under the pubic arch. When for any reason immediate delivery of the child by traction is required, the uterus should be stimulated to contract as the trunk is delivered, by friction with the hand upon the abdomen.

Management of the Third Stage of Labor.

From the moment the head is born one hand of the obstetrician or assistant is held on the abdomen over the uterus. So long as the uterine con-

FIG. 219.

Manual expression of placenta. Method of Credé. (BEERS, from a photograph by H. F. J.)

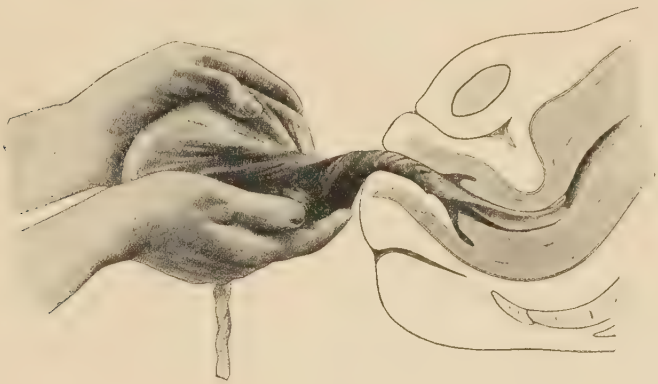
tractions go on normally after the child is expelled, only light pressure and no friction or other manipulation is to be used. Should the uterus remain too much or too persistently relaxed, contraction may be stimulated by gentle friction, moving the abdominal wall with the hand, slowly and in a circular direction, over the anterior wall of the uterus. If more active measures are required to evacuate the uterus, the fundus may be grasped firmly with one or both hands. In spontaneous expulsion, the fundus of the uterus will be observed to rise perceptibly higher in the abdomen at the moment when the placenta is driven down into the lower uterine segment or vagina.

Crede's Method of Expressing the Placenta. The uterus is watched for half an hour after the birth of the child. If by this time the placenta has not been separated and expelled by the unaided contractions, resort is had to Credé's method of expression. This is practiced as follows: The

fundus is grasped with the thumb in front and the fingers behind and a uterine contraction awaited. As the pain reaches its height the fundus is forcibly compressed with the hand and at the same time forced gently downward in the pelvis. (Fig. 219.) The efficiency of the manipulation is greatly increased if the fundus is also crowded backward to bring the uterine more nearly in line with the vaginal axis. Should the first attempt fail, it is repeated with each successive contraction till the afterbirth is expelled from the uterus.

If the compression is practiced at the acme of a pain, and at the same time the woman is required to strain forcibly, the placenta is almost invariably expelled at the first attempt.

FIG. 220.



Twisting the membranes into a rope. (BUMM.)

Manual Extraction of the Placenta. The uterus is to be watched with the hand over the abdomen for half an hour longer till retraction is fully established. Friction or more vigorous manipulation is applied from time to time only as required to maintain normal contractions. If the placenta still remains in the vagina or lower uterine segment, it is drawn down by gentle traction on the cord. When it presents at the vulva it is caught with the hands and careful traction made to separate the membranes should they still be partially adherent.

Examination of the Placenta and Membranes. On expulsion the maternal surface of the placenta is carefully examined to see that no fragment has been left behind. The membranes also are inspected to make sure that both amnion and chorion are complete. This is best done by transmitted light. As a matter of scientific interest, the weight, size, and shape of the placenta, the length of the cord, the site of the umbilical insertion, and the presence or absence of anomalies may be noted.

Retraction of the Uterus. Should the uterus not retract promptly and firmly after the expulsion of the placenta, contractions are stimulated by friction with the hand on the abdomen. When more active measures are required, a half drachm of fluid extract of ergot may be given and repeated p. r. n. One or two doses of ergot are generally advisable when the uterus remains much relaxed, and especially after

chloroform anæsthesia. In small doses this agent is practically harmless, and it fulfils more than one important indication in the management of the final stage of labor. It is useful as a prophylactic, not only against hemorrhage but against sepsis. By maintaining contractions it tends to prevent the accumulation of blood-clots in the uterus, to lessen after-pains, and to close the avenues of absorption. By limiting the blood-supply it promotes involution. The uterus must be watched with the hand on the abdomen till retraction is complete. This will require the attention of the physician or nurse for not less than half an hour.

Care of the Child. On birth of the head the nurse cleanses the face and especially the eyes of the child, the latter best with a saturated boric acid solution or other mild antiseptic. The eyes are carefully dried. This precaution is taken for the prevention of ophthalmia, and is doubly important should there be reason to suspect that the vaginal discharge is infectious. In hospital practice a drop of a 2 per cent. solution of silver nitrate, Credé's solution, or better, a 10 per cent. solution of argyrol, is instilled into each eye of the child at birth. This detail may well be carried out in family practice, and in the presence of a gonorrhœal, septic, or diphtheritic vaginal secretion it is imperative. The application of argyrol is painless and harmless, and it is almost an absolute preventive of purulent conjunctivitis in the new-born.

On the complete expulsion of the child steps should immediately be taken to establish fully the respiratory movements. Mucus in the pharynx may be removed with the finger wrapped with a soft wet piece of cheese-cloth. Still better is a soft rubber tube with a rubber bulb attached. The mucus is sucked up into the tube. Holding the child suspended by the feet favors drainage from the respiratory tract, should it contain liquor amnii or blood drawn into it by premature attempts at respiration.

The contact of cool air with the moist surface of the body, as well as the air-hunger created by the partial interruption of the utero-placental circulation, usually excites respiratory movements. Directly after birth, should the child not promptly begin to breathe, the action of the respiratory muscles may be stimulated by gentle flagellation over the buttocks, by dashing a little cold water upon the face and chest, or by forcibly blowing upon the face.

The treatment of asphyxia neonatorum will be considered in the chapter on Anomalies and Diseases of the New-born Infant.

Ligation of the Cord. The ligation of the cord should, as a rule, be delayed till the child is breathing freely. The infant thus gains from one to three ounces of blood. This post-natal afflux of blood is due to the force of thoracic aspiration. While of comparatively little moment in robust infants, it is often a matter of vital consequence in premature, puny, and feeble children.

The utmost aseptic care must be observed in ligating and dividing the cord. Fatal infection of the umbilical vessels may result from the neglect of proper cleanliness. Ligature and scissors, as well as the hands and everything that comes in contact with the umbilical stump, must be surgically clean. Before tying the cord the physician assures himself that no hernial protrusion has taken place into it. Firm pressure is applied with the thumb and fingers at the point to be ligated to press out the jelly of Wharton. This lessens the risk that hemorrhage may

occur from loosening of the ligature by shrinkage of the stump. The ligature, which may be of narrow linen bobbin about a sixteenth inch in width, is then applied and tied tightly about three-fourths of an inch from the cutaneous junction. The cord is cut with scissors a quarter of an inch beyond the ligature. The end of the stump is pressed with a sterile cheese-cloth to see if its bleeds; should it do so it is tied again. The maternal end of the cord need not, as a rule, be ligated. In case of twins the second ligature should not be omitted, lest the undelivered child perish from blood-loss should the placental circulations communicate.

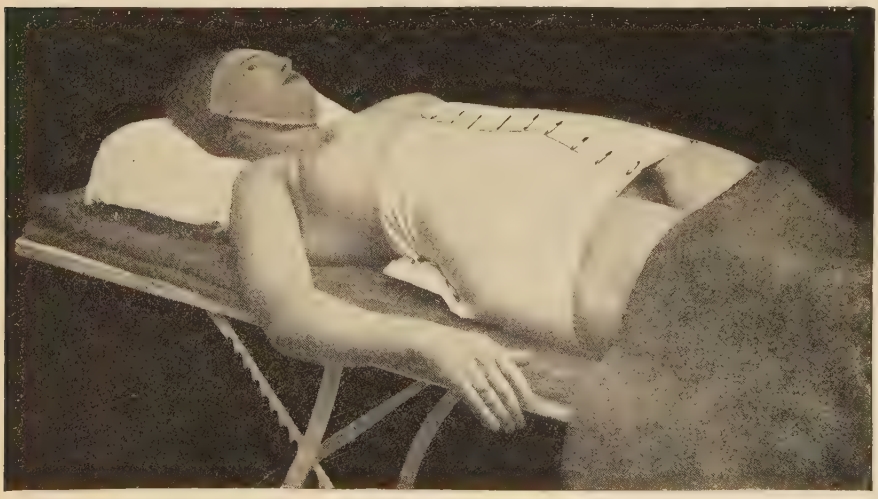
The child is wrapped warmly and laid in a warm place till the necessary attentions to the mother are completed.

Examination of Mother and Child. The physician assures himself of the general condition of the mother, and especially of the pulse-rate, and again examines the uterus with the hand on the abdomen. A careful inspection is made of the vulvar orifice for possible lacerations. Notable injuries should, as a rule, immediately be sutured. The method of suture will be found detailed in the chapter on the Treatment of Lacerations.

The child is carefully examined for the possible existence of developmental anomalies.

Vulvar Dressing. The nurse cleanses all soiled portions of the mother's body, bathing the external genitals with an antiseptic solution, and she removes all soiled linen from the patient and the bed. The vulva

FIG. 221.



Abdominal binder.

is covered with an aseptic napkin which is fastened behind and in front to the abdominal binder when the latter is applied. Instead of the napkin the special dressing already described may be used. These dressings are burnt after once using. Their object is to receive the discharges and, through frequent changing, to promote the cleanliness of the external genitals.

Abdominal Binder. A moderately firm bandage about the abdomen adds to the comfort of the patient after labor. It may be fairly tight

for the first twelve hours for support. After that time it should be slightly looser. This is discarded by the time the woman leaves the bed or earlier. The binder is best made of strong unbleached muslin. It should be wide enough to reach from the great trochanters to the ensiform appendage, and long enough barely to permit the ends to overlap after encircling the body. It is pinned with shield-pins in the median line in front, and then made tight by pinning a fold at each side (Fig. 221). If compresses are used under the binder, one should be placed above and one on each side of the uterus.

Final Duties. Before leaving the physician again takes note of the condition of the mother, and examines the child to see that all is normal. The nurse is given full instructions with reference to the care of the mother and child. One or two doses of ergot and a prescription for relieving after-pains are left, to be used if required.

PART IV.

PHYSIOLOGY OF THE PUERPERIUM.

CHAPTER X.

THE PUERPERAL STATE.

Definition. By the puerperal period is meant the time which elapses after childbirth during which the changes observed in the course of labor and pregnancy are being effaced and the body is returning more or less approximately to the state in which it was before impregnation. But, since these progressive and retrogressive alterations chiefly involve the generative organs, we may leave out of consideration the general constitutional changes, and for practical purposes limit our definition so that the puerperium may signify "that period after labor in which the genitalia are regaining the condition proper to those of the non-gravid woman." In the case of women who have previously borne children, the condition reached at the end of the puerperium should, except as regards the inevitable local changes, be that observed before the last pregnancy. In the case of primiparæ, the previous nulliparous condition is never regained. Certain changes have taken place in the genitalia and in the abdominal walls which are permanent and which are accompanied with more or less certain indications that at least one labor has occurred.

The puerperium may, therefore, be said to begin immediately after the delivery of the placenta and to end with the complete involution and regeneration of the internal genitals. Exact anatomical observations have proved that the processes involved usually take about six weeks. Between individual cases the variations may be considerable. It is interesting to note that the limits of the period had been established long before our modern scientific methods of examination were known. It is not hard to see how the older obstetricians made so correct calculations. Experience had taught them that after six weeks the normal functions of the non-impregnated genitalia—namely, menstruation and conception—could begin again. It is true that in nursing women menstruation rarely occurs at so early a date, but it is a well-known fact that it is possible for them from this time forward to conceive again, the possibility becoming greater every month.

Introductory Remarks. Pregnancy, labor, and the puerperal state are, under ordinary circumstances, natural processes, but in all of them the physiological borders so closely upon the pathological that it is extremely difficult to draw a hard-and-fast line between the two. Of necessity,

then, in descriptions of the so-called normal puerperium and its management, it is almost impossible to avoid touching upon certain minor pathological conditions, which are not severe enough to bring about any serious results.

The puerperal woman has been aptly compared to a person suffering from a recent more or less severe wound. Provided the patient has been in a normal condition previously, and that the wound be not too severe and can be kept surgically clean, beyond the weakness caused by pain, loss of blood, and a certain amount of nervous shock, there is nothing to interfere with a speedy recovery. But once allow infectious material to enter the wound, a series of pathological processes ensue which materially alter the features of the case. In the puerperal woman we have to deal with open wounds extending over a large surface, a contused condition of the genitalia, exhaustion following labor, and a condition of more or less marked nervous shock. Here, then, we have a condition physiological, perhaps, but easily transformed into a most serious pathological state. Everything, it may be said, is present which would render the occurrence of infection peculiarly easy. The open wounds and contused surfaces offer a decreased local resistance; the lochial discharge and the blood-clots in the uterine sinuses at the placental site form excellent media for bacterial growth. The very number of the small lacerations increases the chances that any poison introduced may find a congenial nidus where it can produce a localized pathological process or from which it can spread and infect the whole system. Added to this we have the general weakness and exhaustion of the whole body, which offers decreased resistance to the attack of any pathogenic agent. Thus it will easily be seen that for the bringing about of a normal puerperium prophylactic measures play the most important part, and when complications arise after a normal labor the obstetrician has always to ask himself how far he has been responsible for their existence and in what way his technique has been faulty. Nothing can be more satisfactory to the physician than to see his patient who has just undergone perhaps the most severe trial and suffering which she has ever experienced, regaining almost perceptibly from hour to hour her former health and strength, and nothing is more painful to watch than the course of a puerperal infection, which if not fatal is always serious, and may leave behind it irreparable damage, especially when he has to confess that the cause for the whole trouble probably lies in some apparently trivial error, either of omission or commission, which has occurred in the course of what should be a physiological process.

We shall now take up in detail the changes which take place in the genitalia during the puerperium.

Outlet and Vagina. In primiparæ the hymen and the fourchette are almost invariably torn, and such tears are of no import. Deeper lacerations, especially those extending into the perineal body or into the bowel, though at times not preventable, must always be considered as pathological. The tear in the hymen is usually stellate, and after involution traces of the membrane are found in the small bodies surrounding the outlet, the so-called caruncule myrtiformes. The whole vagina has been dilated during labor, but, though in all cases microscopic lacerations probably occur, the elasticity of the tissues of the canal generally prevents the occurrence of

any serious injury. The external and internal parts, however, are always more or less contused, œdematous, and hyperæmic. Small lacerations usually heal spontaneously, if kept clean. The more serious tears, when coaptation of the wounded surfaces does not occur spontaneously, if neglected, heal chiefly by granulation and cicatrization, and may leave extensive areas of scar-tissue behind them. Lacerations in the anterior wall of the vagina may give rise to troublesome vesico-vaginal, urethro-vaginal, or even vesico-urethro-vaginal fistulæ. A vesico-vaginal fistula at the site of the vesical trigone is an especially troublesome complication. As a consequence of the laceration of the anterior vaginal wall, prolapse of the wall with cystocele may occur. Lacerations in the posterior wall may or may not communicate with the peritoneal cavity or rectum. Superficial tears in this region are not unusual. An overstretching of the outlet, or lacerations which have severed some of the fibres of the levator ani muscle, are frequently found. In not a few instances the function of the levator ani is permanently impaired. The anterior fibres of this muscle furnish the chief support of the outlet; acting from the pubic bones they pull the vaginal orifice upward and forward, away from the direct line of intra-abdominal pressure. If, therefore, the function of these fibres be put in abeyance, prolapse of the vaginal walls and descent or prolapse of the uterus must almost certainly follow. The treatment of serious injuries of this muscle has been discussed elsewhere.

Normally the small tears of the vagina soon heal promptly, sometimes by first intention, despite their continuous lochial bath. More or less extensive cicatrices may be left behind to mark their previous situation. The vagina becomes smaller and narrower, and from being smooth becomes wrinkled, though the rugæ are never so deep or as well marked as in the primipara. The swollen, succulent, and hyperæmic condition gradually subsides. Should there occur no unusual or pathological amount of cicatrization, the vagina at the end of the puerperium will be found roomier than in the primipara and somewhat shorter. The outlet will be considerably larger than before, but should be still held up closely under the pubic arch by the action of the levator-ani muscle and be capable of effective contraction and narrowing by the joint action of this muscle and of the constrictor cunni. The rima vulvæ should be almost entirely closed.

Uterus. The uterus as a whole immediately after labor is said to weigh from 800 to 1000 grammes. It measures from 15 to 20 cm. in length, and from 11 to 12 cm. in breadth at the level of the Fallopian tubes. The wall of the upper uterine segment measures 3 to 4 cm. in thickness. The uterine cavity (sound measurement) is 15 to 16 cm. in length. The following table shows the comparative measurements of virginal and multiparous uteri, made by Sappey, Richet, and Henning:

	Virgin.	*Nullipara.*	*Multipara.*
Length of uterus	5.8 cm.	6.2 cm.	6.8 cm.
Width	3 "	3.9 "	4.2 "
Thickness	2.1 "	2.3 "	2.5 "
Vertical diameter of cavity	4.5 "	....	6.1 "
Capacity of the uterus	....	2 to 3 "	3 to 5 "
Length of entire organ in young women		5.6 "	
Weight of virgin uterus	40 grammes.		

It will be seen from these figures that the parous is in all its dimensions somewhat larger than the virgin uterus. The cervical portion is also shorter than in the virginal condition. The arbor vitæ is partially effaced. The sound measurements of the uterus during the puerperium, as given by Hansen, are as follows:

Tenth day, 8 to 13.5 cm.
Fifteenth day, 8.3 to 11.5 cm.
Third week, 7.5 to 10.5 cm.
Fourth week, 7 to 9.3 cm.
Fifth week, 6.5 to 9 cm.
Sixth week, 6.2 to 9.1 cm.
Eighth week, 5.6 to 8.5 cm.
Tenth week, 5.4 to 7.5 cm.

Immediately after the expulsion of the placenta the fundus of the uterus should be felt as the upper extremity of a globular body half-way between the umbilicus and the upper border of the symphysis. In about six hours, however, it will be found to have risen again and to be about on a level with the umbilicus, or usually about 11 cm. above the symphysis, the greatest breadth of the uterus at the time being about 10 cm. From this time it diminishes rapidly in size, so that by the ninth, tenth, or twelfth day the fundus should be found at the level of the upper border of the symphysis, the body of the uterus lying entirely in the true pelvis. The uterus should at this time be somewhat anteverted or anteflexed. Involution also goes on in the cervical canal and in the portio vaginalis. Immediately after birth the cervix hangs down into the vagina, as a thin, flaccid ring, in marked contrast to the firmly contracted uterine body above. Gradually the tissues regain their elasticity and the regenerated portio vaginalis contracts. At first the cervical canal measures 7 cm., but already on the second day contraction has begun. At the beginning of the second week the portio vaginalis has about regained its usual size and consistence.

Uterine Muscular Tissue. During pregnancy the muscle cells are greatly increased in size, attaining from ten to twelve times their former length and from three to five times their normal breadth. Although the fact was formerly much disputed, it is now generally recognized that there is also a new formation of muscle cells. After labor, therefore, we have an enormous amount of tissue which disappears, the uterus losing in the first two weeks about a pound in weight. This takes place as a result of fatty degeneration. It is a well-known fact that if any organ or part of an organ in the body is deprived of nourishment it undergoes fatty degeneration and subsequently at least partial absorption. Now, the strong contractions of the uterus lessen the blood-supply, and by cutting off the nutrition cause the degeneration of the superabundant amount of tissue. It is clear, therefore, in the absence of sufficiently powerful contractions the uterus cannot reach, at least within the normal time, the appropriate state of involution.

It is a disputed point whether or not these enlarged muscle cells totally disappear and are replaced by newly formed cells. Some authorities hold that the majority, if not all, of these large cells are entirely destroyed, and that the involuted uterus is made up of new cells. The weight of the evidence, however, seems to favor the view that the large cells undergo

degeneration only up to a certain point, and that the process then comes to a standstill, so that the atrophy ceases as soon as the cells have reached their original size. It is certain that they do not become quite as small as formerly, or if they do some of the newly formed cells must persist, since the parous uterus is always somewhat larger than that of the virgin.

The connective tissue undergoes similar changes.

Uterine Vessels and Nerves. The bloodvessels, lymphatics, and nerves have participated in the general growth during pregnancy, and have increased in length and diameter. The arteries have correspondingly thicker walls, except in the case of those which run in the decidua, where the walls are thinner than usual for vessels of so large a size. On account of their length they take a tortuous course, and many communicate directly with veins. At the placental site some of the sinuses have been closed by thrombi in the last month of pregnancy. Those which remain open till after delivery are closed by the contractions of the uterus, which bring their walls in close apposition, causing the formation of a clot, which later on undergoes organization. Other vessels of the uterus undergo pressure atrophy, and are finally obliterated, the obliteration in some cases being brought about by excessive growth of their walls. In examining sections of parous uteri, these vessels, with much thickened coats, are often met with and in many cases undoubtedly persist after the process of involution is finished.

Uterine Mucosa. The mucosa, which measures only a few millimetres in thickness, may be divided for purpose of description into two layers. The inner, which forms the decidua, is very poorly provided with glandular elements, and on section seems to be made up almost entirely of decidual cells with small round mononuclear cells resembling lymphocytes scattered through it. This has been termed the "cellular layer." The outer layer is composed entirely of convoluted glands, which give to the section a honeycombed appearance. The epithelium is cuboidal and fatty, and a considerable portion of it is desquamated. This layer is known as the "honeycomb" or "glandular" layer. The inner or cellular layer is for the most part thrown off along with the decidua. Of the outer or glandular layer, a portion remains behind, and from it the new mucosa or endometrium is formed. The process is strongly suggestive of one of transplantation. The tubes of the glands have, in part, retained their epithelium, so that we have as it were, islands from which the regeneration spreads, and what at first was apparently a raw surface is gradually covered. The tissue which is not utilized in the process undergoes fatty degeneration and is thrown off.

Patches of pigment are found for a considerable time in the endometrium, especially at the seat of the placenta, where they persist longer than elsewhere. The placental site is probably the last to receive its protecting coat of epithelium. This is doubtless due to peculiarities in the histological structure of the glandular layer at this point, very little trace of it being seen.

By the end of the fifth or sixth week the new endometrium is probably complete.

Tubes, Ovaries, and Parametrial Tissues. During pregnancy the tubes are elongated and somewhat thickened, the parametrial tissues are also hypertrophied, and all the adnexa are hyperæmic. After delivery this hyperæmia subsides and a physiological atrophy takes place until the

organs regain approximately their original size. The corpus luteum, which may be still present after labor, gradually shrivels, and as time goes on becomes more deeply embedded in the ovary until it finally disappears or can be demonstrated only by the microscope.

Lochia. For the source of the lochia we have not far to look when we consider that we are dealing with an extensive open wound and with the removal of a comparatively large quantity of detritus from the tissues in the course of involution. From an open wound comes at first blood, and similarly in this case we have for the first few hours and days a bloody fluid, the *lochia rubra vel cruenta*. The microscopic examination of the secretion shows numerous red blood-corpuscles, portions of clots, and of decidual shreds. After a few days the secretion still stains the napkins a reddish-brown color, but the fragments have a pale yellowish appearance. The lochia after a week contain serum mixed with the coloring matter of the blood, together with scattered flat epithelial and cylindrical cells, and are called *lochia serosa*. As the external wounds gradually take on granulations, leucocytes are mixed with the secretion. These cells are at first few in number, but increase until after the end of the second week; the secretion is purulent, the *lochia alba vel purulenta*. These changes take place gradually; approximately it may be said that the lochia rubra appear for three days; the lochia serosa from the third to the eighth day contain much albumin, mucin, fat, chlorides, and phosphates, their reaction being alkaline. In the second week the lochia alba appear, containing leucocytes, fat, cholesterin, and a few connective-tissue cells. The normal acid secretions of the vagina finally give to the lochia an acid reaction. The flow from the uterus itself should always be sterile, and for the first day or two the lochia normally contain no micro-organisms. It is not, however, unusual for their presence to be demonstrable in the secretion later, and provided that they come only from the vagina their occurrence must not be considered abnormal.

The amount of the lochia has been variously estimated by different authors. Gassner, quoted by Winckel, gives the following figures:

Lochia cruenta	1000 grammes.
Lochia serosa	260 "
Lochia alba	205 "

The amount necessarily varies in different cases. Where there is faulty involution the lochia are more profuse. In nursing women the duration of the flow is generally shorter than in the cases in which the women do not suckle their children. The discharge diminishes gradually, and usually disappears entirely between the second and the sixth week.

After-pains. The changes going on in the inner genitalia are brought about principally by contractions of the uterus, occurring at more or less regular intervals, and which are sometimes appreciated by the patient, since they produce what are called "after-pains." It is to be noted that primiparæ seldom complain much of these pains, so that when they are at all marked some pathological process is generally to be suspected. In multiparæ they occur quite frequently, but can usually be easily controlled. The intensity of the after-pains is in inverse proportion to the strength of the uterine contractions during parturition, so that, as a rule, patients who have had a speedy, almost painless, labor, are apt to suffer more during the puerperium.

Urine. Notwithstanding the great activity of the skin after labor the amount of urine excreted by the kidneys should be rather more abundant in quantity than under ordinary circumstances. The woman may, however, pass but little urine at first, and after the first five or six hours the bladder may become much distended. Three factors contribute to bring about this accumulation: (1) The amount of urine passing into the bladder from the kidneys is greater than usual. (2) The expulsion of the contents of the uterus, the child, placenta, and liquor amnii, has removed quite a large mass from the maternal body, as a consequence of which the intra-abdominal pressure is decreased and the abdominal walls are flaccid, the bladder being thus allowed more room to expand and less resistance being exerted to its distention. (3) The woman, finding, perhaps, that a few drops of the urine trickling down over small lacerations of the outer genitalia cause a disagreeable smarting sensation, may thus be led almost unconsciously to retain her urine as long as possible.

The increase in amount seems to be mainly in the water, the urine being of rather a lower specific gravity than usual. The total amount of urea excreted is practically unchanged, the increase, if any, being quite insignificant. Sodium chloride is present in relatively larger amounts; phosphoric and sulphuric acids are both somewhat increased. Peptone is usually found in the urine. Its presence bears probably some relation to the involution of the uterus, since it is found from the second half of the first day after labor to the seventh day. Winckel reports a case of Porro's operation in which it was absent. Acetone is said to be a constant constitutent of the urine of puerperal women. Albumin may be found in some cases, due to a temporary renal hyperæmia, but its presence must be considered abnormal, and its persistence is always of grave import. The presence of sugar in the urine for a few days is not necessarily a serious symptom, and is commonly to be explained by reabsorption of milk-sugar from the mammary secretion. Its occurrence is not rare and is more especially frequent in cases in which there is distention of the breasts either from over-secretion or from failure on the part of the child to utilize the proper amount of milk.

Bowels. The bowels are apt to be sluggish at first, and do not move naturally for several days. This may be accounted for principally by the lessened intra-abdominal pressure. The fact that the woman receives only a liquid diet, and that the watery parts are given off in a great measure through the skin, and in the milk, urine, and lochia, leaves little solid fecal matter to be evacuated, especially if the bowels have been well cleared out before labor. That lessened peristalsis does not play much part in causing the constipation is proved by the fact that the excreta are passed along the bowels, the rectum being in many cases enormously distended.

Temperature. In view of the extensive changes which are going on in the body and the great amount of material to be absorbed and eliminated, it certainly would at first sight appear extraordinary that the process is not accompanied by grave pathological symptoms. Under ordinary circumstances it might be expected that the absorption of a pound or more of tissue which undergoes retrogressive metabolism would certainly give rise to a high temperature. Careful observations, however, based upon long experience have proved beyond doubt, that normally the puerperium passes without fever. In the past it was an established belief that the puerpera during the first few days, especially when the secretion of milk

began, must have fever. This idea was rendered more plausible by the fact that not a few women, especially primiparæ, undergo no little emotional excitement. The pain which accompanies the secretion of milk, some difficulty in coaxing the child to nurse, the soreness experienced when it seizes the nipples, all tend to excite and worry the mother, especially if she be a primipara. The physician or nurse finds the pulse quickened, the face red, and the patient complaining of exhaustion, and, possibly, of severe headache. Surely under these circumstances it was not unreasonable to say that fever was present. The clinical thermometer, however, has upset entirely this opinion.

There is No Such Thing as Milk Fever. The secretion of milk of itself, be the breast ever so hard or swollen, goes on in innumerable cases without a rise of temperature. Careful observation has also proved that retention of milk does not cause fever. Elevations of temperature may be caused by trifling circumstances, but if the rise is not very slight and quite transient we are in face of some pathological factor. Zweifel holds that a temperature of 37.6° C. or 37.7° C., 99.5°–100° F., in the axilla is always pathological. Whitridge Williams believes that the upper limit of temperature for a normal case may be as high as 100.4°F. (38°C.), without an assignable cause. *If the puerpera has not been subjected to harmful influences she will have no fever. Milk fever is traumatic fever, and traumatic fever means infection.*

It is hardly possible to repeat this fact too often, for if it is neglected valuable time may be wasted in vain hopes, when a rigid search might reveal the pathological cause and enable us at once to institute measures to rectify the conditon.

The Pulse. After completion of the third stage the pulse usually decreases very markedly in rapidity. The first sound of the heart often takes on a soft murmurish tone. This change may not occur at once, but usually takes place within the first twelve hours, the rate falling to 60 or less, and in exceptional instances to 40 per minute. A pulse as low as 34 has been recorded. The arterial tension is not increased. The duration of this slowing of the heart varies in individual cases, being usually in direct proportion to the lowness of the rate. No completely satisfactory explanation of this phenomenon has been arrived at. Doubtless the complete physical and mental rest, coming as it does after a period of anxiety and suffering, plays an important part, although it does not by any means of itself afford a sufficient explanation. Olshausen thought that the absorption of fat and the presence of fat emboli could account for the slowing of the pulse. It is possible that the stasis occurring in the abdominal veins may account in part for the slowing of the circulation, or that the shutting off of a great mass of blood going to the uterus, by relieving the heart of some of its work, may act in the same way. Both these theories, however, are rendered somewhat unsatisfactory from the fact that the slowing of the pulse also occurs after early abortions, in which the shutting off of the utero-placental circulation or stasis in the abdominal veins could hardly figure as relieving the heart of much extra work. The same objection applies to the attempt to find an explanation in the increase of the pulmonary capacity as a consequence of the expulsion of a large abdominal tumor. It is only natural that the rate and character of the pulse of the puerpera may be temporarily influenced by very trifling causes.

The Respiration. At one time it was held that the pulmonary capacity was increased after labor. Modern investigations, however, do not bear out this assumption. Out of 50 cases examined by Vagas the pulmonary capacity was found to be the same as before labor in 26 cases. It was increased in 17 and decreased in 7 cases. The character of the respirations is not markedly altered.

The Skin. Formerly the "puerperal sweats" were well known. They were noted especially during sleep and often attended by what was thought to be a characteristic odor, which was probably dependent upon the presence of fatty acids, and often accompanies severe sweating. The older obstetricians welcomed their appearance and regarded their absence as a somewhat ominous sign. At the present day, now that the close, overheated lying-in chamber has given place to the cool, well-ventilated room, one rarely sees drops of sweat upon the forehead of the puerperal woman.

The skin of the abdomen shows shining whitish or reddish lines, which at a later date become quite white, the lineæ albicantes. These are usually arranged in the form of crescents running from the groin toward the umbilicus, and are far more numerous and more deeply marked below the navel than above it. They are caused by overstretching of the skin during pregnancy and the subsequent replacement of part of the corium by scar tissue. Areas of pigmentation which have appeared on the face, abdomen, around the nipples, and elsewhere on the body during pregnancy, gradually begin to fade during the puerperium, although, as a rule, they do not entirely disappear. The areolæ of pigmentation around the nipples, more marked in brunettes, grow less conspicuous, but are never entirely obliterated.

The Digestive Apparatus. Just as the excretions of one organ serve to nourish other organs, it is not improbable that a considerable amount of the products of the involution going on in the genitalia is utilized as food for the other tissues of the body; but that all are not so used is proved by the fact that peptone can be demonstrated in the urine. The power of the digestion of solid food is for a time enfeebled. Thirst is usually present, and is easily accounted for by the great drain of water from the body in the increased perspiration, the lochia, the milk, and the urinary secretion. The sluggishness of the bowels has already been referred to.

Loss in Weight. As elimination exceeds ingestion, it is self-evident that the puerperal woman must lose considerably in weight. The amount lost has been variously estimated as from one-twelfth to one-eighth of the entire body-weight in the first seven days. Non-nursing women and primiparæ lose less than nursing mothers and multiparæ, the loss being actually, though not relatively, greater in proportion to the normal body weight. Under ordinary circumstances the diminution should cease at the latest by the ninth day.

Lactation. The breasts for a short time after labor afford a secretion similar to that which they contained during pregnancy. This early milk, or, as it is called, "colostrum," is a whitish or faint yellowish, viscid fluid resembling milk, but differs from it chemically in being richer in sugar, fat, and salts. It seems to have a laxative effect upon the child, and sweeps away the meconium from the bowels. This action has been attributed to the separate or collective effect of the excess of the several

ingredients. One author advances the view that it acts by its indigestibility. Microscopically it differs from milk in containing the so-called "colostrum" cell, which is nothing more nor less than a large epithelial cell studded with fat globules. The fat globules of the colostrum are not as uniform in size as those of milk.

The true milk secretion begins about the second day or occasionally on the third day. The breasts, which have already enlarged during pregnancy, become still more tense and swell to such a degree that they are often very sensitive, and may be the seat of considerable pain. The pain and emotional disturbance, especially if there is trouble in making the infant take the breast, may give rise to a slight elevation of temperature. The so-called milk fever, a myth of the prebacterial stage of medical knowledge, has been discussed. Microscopically, human milk is seen to consist of minute oil globules of rather uniform size, floating in a transparent, colorless plasma. Human milk, like that of all other animals, is an emulsion. The emulsifying agent is an albuminoid, the casein. The plasma contains milk-sugar and inorganic salts. The fats, sugar, and casein are produced from the cells of the acini of the glands. The liquid portion, the plasma, is obtained from the blood. As regards its chemical constitution, milk varies in different women or at different times, and even in the two breasts of the same woman. The approximate chemical composition of rich human milk is shown in the following table:

Water	88 9 per cent.
Solids	11.1 "
Casein	3.82 "
Fat	2 66 "
Milk-sugar	4.36 "
Inorganic salts	0.14 "

The quantity of milk secreted varies also in different women and at different times. During the first three days the whole amount may be between 50 and 200 cc., but the quantity rises rapidly, until by the ninth day 400 to 450 cc. are being secreted daily. The character of the milk is altered by various conditions of the mother. Certain medicines when given the mother are given off almost unchanged in the milk secretion, and may seriously disagree with the nursing child. It has been found also that mental or physical disturbance in the mother may so alter her milk so as to render it unwholesome. The reappearance of the menstrual function makes a change in the character of the milk. The disturbance, however, is usually temporary, and subsides immediately after the menstrual period.

In women who do not suckle their children milk secretion goes on for a couple of days; during this time the colostrum corpuscles gradually decrease, but again show a relative increase. The breast undergoes a physiological atrophy; the secretion gradually becomes less, until at the end of from fourteen to sixteen days it practically ceases.

The period of lactation may be said to last for almost one year, though at the end of the sixth or eighth month the quantity and quality of the milk secreted often begin to fall off. Some women nurse their children far into the second year, but the nutritive properties of the milk are of necessity very poor.

Care of the Puerperal Woman.

Remembering that the puerperium after a properly conducted labor is a natural condition, it remains for the obstetrician, while abstaining strenuously from meddlesome interference with nature, to take such precautions as shall prevent the physiological from merging into the pathological upon which it so nearly borders in these cases. The main treatment may conveniently be discussed under three heads: (1) proper nutrition; (2) absolute rest of body and mind; (3) proper hygiene with aseptic treatment of the wounded parts.

Nourishment. Liquids should be given for the first two or three days. Milk is the best food, but an occasional cup of beef-tea, clear soup, or weak cocoa is often very grateful to the patient. For thirst, water must be principally given, but a cup of tea, if the patient expresses a desire for it, will do no harm. After the third day a gradual return to the usual diet may be made. After the first week extra nourishment, preferably in the shape of milk between meals, should be allowed. Malt liquors or wines are usually unnecessary; if, however, the woman is habituated to a moderate use of them they may be allowed in very small quantities. The patient's own tastes may be consulted and will usually serve as a guide for the diet to be given, provided nothing too heavy or manifestly indigestible be desired. If the patient is fond of eggs they form a very nourishing food, and can be given to her prepared in a number of different appetizing forms.

Rest. The puerpera should have complete bodily and, what is just as important, absolute mental rest. After remaining quiet for a few minutes after the completion of the third stage of labor, the mother usually desires to see her child. This wish may generally be gratified; but as soon as possible after the linen has been changed and she has been made comfortable the room should be moderately darkened and the patient should be left to sleep. After she awakes the infant may be put to the breast for a few minutes. For the first two or three days the woman should be kept flat on her back, with the head only a little raised on a small pillow. When nursing the infant she may assume the lateral position, if this is found to be more convenient, but all sudden changes of position, especially the sudden arising into a sitting or standing posture, for the first few days must be strenuously avoided. Neglect of such precautions has not infrequently been followed by fatal syncope. After the uterus has had time to contract firmly and the sinuses have been permanently closed, the danger becomes minimized; but it is, nevertheless, advisable to avoid any sudden change of posture for some time. It is well to secure greater safety, even at the expense of a little discomfort, and for the first few days not to allow her to rise even to pass urine or to have a movement from the bowels; for this purpose she should be induced to use the bed-pan. It is not uncommon for patients to experience considerable difficulty in passing the urine while in the recumbent position; this, however, may generally be obviated by applying a warm wet aseptic compress to the vulva. Occasionally the sound of a little water trickling into the bed-pan will have a salutary effect. If no urine has been passed for over eight hours, and the various simple expedients have failed to cause the patient to urinate voluntarily, she will have to be catheterized.

Glass catheters are cheap, and if broken can readily be replaced. They are better than those of other material, since they can easily and certainly be kept aseptic. Before and after use they should be thoroughly cleansed with hot water, and in the intervals may be kept in 1:40 carbolic-acid solution. Before being used the catheter is rinsed thoroughly in sterilized water in order to free it from the carbolic acid. Catheterization demands complete exposure of the parts, and as thorough asepsis as possible. Without the former the latter is impossible, and catheterization under the bedclothes is inadmissible. A little tact will generally suffice to overcome the objections of any patient who has been accustomed to the old method and who may feel a little sensitive about the procedure. The external genitals, more particularly the parts immediately around the meatus, should be cleansed from lochia and the labia be held apart while the catheter is being introduced. These precautions are necessary every time catheterization is employed if we wish to provide against the chances of setting up what may probably be a serious cystitis. When it has been found necessary to draw off the urine the catheter should be used once, and as soon as the bladder begins again to be moderately distended the patient should be urged to make several efforts at emptying the bladder spontaneously. If she is unsuccessful in her attempts she should not be allowed to go more than eight hours without having her bladder emptied. In a few cases repeated catheterization will be forced upon us, but we should not fail to do our utmost to obviate the necessity as soon as possible.

The bowels should be opened by the third day. This is best accomplished, if it does not occur spontaneously, by some simple enema, preferably of soap and water. Should this prove ineffectual, and large masses of feces be present in the rectum, three or four ounces of sweet oil may be injected carefully and allowed to remain for half an hour, after which another simple enema may be given. A dose of castor oil, given in capsules if preferred, will generally aid very much in bringing about a satisfactory result. Care should be exercised in giving medicines to the nursing woman, since many drugs, notably the minerals and rhubarb, are excreted partially in the milk secretion, and may thus disturb the digestion of the child. Salts are not recommended in these cases, because they are supposed to diminish the secretion of milk; in many instances, however, especially when there is abundance of milk, they seem to act well.

Perfect mental rest is of the greatest importance to the puerperal woman. A short nap will do more to strengthen and invigorate her than any amount of congratulations on the part of relatives and friends. With the exception of the husband or mother, who may be allowed to remain if their presence seems to quiet and comfort the patient and does not interfere with her rest and sleep, all other visitors should be rigorously excluded. The child should not be kept near enough to disturb her by its cries, and should under no circumstance be allowed to sleep in the same bed with its mother. If this rule were always carried out the rate of mortality from "overlying" would be considerably diminished. Until she has regained her strength the patient should be kept free from all household cares. These should be delegated to the nurse or some other competent person. The anxieties and troubles of others should not

be brought to her for sympathy. Excessive joy or grief has not infrequently caused death in puerperal women. Mental emotion has been known to bring about inhibition of the contractions of the uterus, and thus to cause dangerous flooding, and even if it does not produce serious symptoms, excitement always interferes with the proper progress of convalescence.

The Lying-in Room, whenever it is possible, should be in some quiet part of the house as far removed as possible from the noise of the household and street. It should be well lighted and airy, but should be so arranged that it can be shaded when necessary, since a partially darkened room is more productive of rest and sleep. The light should never strike directly into the patient's eyes, and there should be no perceptible draughts. Ventilation should be so arranged that no one on entering should be able to detect any odor. The temperature should be kept steadily between 60° and 70° F. No noise or disturbance should be permitted. At no time must the lying-in room be made a general meeting place for a large circle of relatives and friends. The woman's linen and the bed should be kept scrupulously clean. Frequent changes of the napkins and bed linen should be made. This can be done readily, without disturbing the patient, by making use of draw sheets.

After-pains. In primiparæ, as has been said, the after-pains are rarely severe enough to demand interference. In multiparæ, on the other hand, they may be very annoying and may seriously discommode the patient, interfering with sleep and rendering her miserable. Under such circumstances some treatment must be instituted. The physician should never consider any discomfort of his patient as too trivial for his serious attention, and although at times he may not think it wise to have recourse to drugs for her relief, he will not hesitate to employ them whenever the situation demands it. Opium or its alkaloid, morphine, relieves pains more effectually than any other drug in the *Pharmacopœia*, but is not always well tolerated. Chloral alone, even in comparatively large doses of 15 or 30 grains, is not very efficacious in relieving pain, although its effect is quieting. Some such combination as the following generally acts very well:

Morphinæ sulphatis	gr. ⅛–¼
Chloral hydrate	gr. 10–20

Bromides are practically worthless against acute pain. They act slowly and very feebly. Antipyrine, antifebrine or acetanilid, and phenacetin have considerable analgesic action and are occasionally of service. Their use should, however, in no case be prolonged, as they are all depressants and are said to interfere with involution. Should opium be given it is necessary to keep its constipating action in mind and be governed accordingly.

Care of the Genitalia. If the labor has been normal and no instruments have been used, and no incautious or too frequent vaginal examinations have been made, it is safe to assume that the condition of the genitalia is physiological, and consequently demands only rigid asepsis to keep it so. No vaginal douches are necessary after the completion of the third stage. The vulva should be washed off with a stream of sterilized water, its action being aided by gentle friction with sterilized fingers or pledgets of sterilized cotton held in the forceps, and should then be protected by a

generous dressing of sterilized cotton or gauze. The dressings should be changed every hour or two for the first six or eight hours, and during the next day every three hours. After this they should be changed three or more times daily, according to the amount of soiling. When the dressings are removed the external genitals should be cleansed of lochia, and should then be washed with an antiseptic solution, which in turn should be removed with sterilized water. For this purpose under ordinary circumstances a saturated solution of boric acid acts best. A 1 to 2000 or 3000 solution of bichloride might be used, provided one could be sure that none of it was allowed to enter the vagina. In view of the fact that considerable danger of mercurial poisoning exists, it is better to make use of some less toxic antiseptic. A 2 per cent. or a 1 per cent. solution of creolin may be employed, but the odor may render its use disagreeable to the patient. Should the discharge become fetid, antiseptic douches may be called for. Bichloride of mercury and carbolic acid are dangerous in the condition in which the vagina and uterus are at this time, but may be employed with caution in weak solutions and when carefully controlled by the physician. A 1 per cent. solution of lysol, a 2 per cent. solution of creolin, hydrogen peroxide in full strength, diluted chlorine water, and permanganate of potash in weak solutions have their advocates. Should the woman show evidences of infection the case ceases to be physiological and becomes pathological. The proper course to be pursued under such circumstances will be found in the section on the Pathology of the Puerperium.

Nursing the Child. Four or six hours after labor, after the mother has been refreshed by a good sleep, the child may be put to the breast for a few minutes, and then for two or three days, until the secretion of milk is established, at intervals of four hours, after which it should be nursed every two hours from 6 A.M. to 10 P.M. In this way the child receives nourishment nine times in the twenty-four hours, and the mother can obtain seven hours or more of uninterrupted sleep. Occasionally one nursing at night is necessary. Without regularity in nursing it is hardly possible for either mother or child to do well, and many cases of severe debility and anæmia in nursing women are due mainly to over-frequency in nursing, while the stomach of the child, from want of rest and improper quality of the milk, is also seriously disturbed. The nipples should be gently cleansed after and before each nursing with a saturated solution of boric acid, and should then be dried by patting with some soft absorbent material. No rubbing should be employed. Should the nipples tend to become sore or cracked, inunction with a little cacao-butter, after each nursing and cleansing, may do valuable service by protecting them from the air and by softening and rendering the skin more pliable. The mother may, perhaps, be unwilling to suckle the child, but when no contraindication exists she should be persuaded to do so for her own sake and for the child's welfare. The act of suckling promotes involution in the genitalia through reflex nervous action, and thus the mother is benefited. For the infant no food is so suitable as its mother's milk, and thus the child is benefited. There are, however, certain conditions in which nursing the infant may be impossible or inadvisable. In cases in which the mother's health is very feeble lactation might be too serious a drain upon her. Under such circumstances it will be better for the infant, too, to pro-

hibit suckling, as the mother's milk will almost certainly be defective in quality or quantity, and probably in both. A tuberculous mother, even when comparatively strong, should not suckle her child, for fear that she might infect the infant. This same rule applies also to cases in which the woman has contracted syphilis late in pregnancy, since it is just possible that the child may not be syphilitic. If, however, the disease was inoculated previous to or at the time of conception the child should be suckled by its mother, unless other contraindications exist. It is not right to subject a non-syphilitic wet-nurse to the risk of infection by allowing her to suckle the infant of a syphilitic mother, even should all signs of syphilis in the child be lacking. The condition of the breasts may contraindicate nursing the child; inversion of the nipples, cracked nipples, mastitis, or defective secretion may render suckling impossible or inadvisable. Defect in the quality or quantity of the breast-milk will quickly make itself apparent by the fact that the child does not thrive or gain in weight as it should, even if it shows no signs of serious digestive disturbance. Moderate "over-feeding" of the mother, combined with general tonic and supporting treatment and proper hygienic measures, will often rectify this faulty condition. It is, of course, necessary to see that the over-feeding does not go far enough to injure the woman's digestion. The exhibition of drugs, of which there is so long a list under the heading of galactagogues, rarely, if ever, does any good. In many cases the use of them undoubtedly does harm. Strychnine, iron, and quinine in tonic doses are frequently beneficial. It is well to order a certain amount of milk at intervals during the day; if taken between meals it often agrees better. Malt liquors or extract of malt in moderate doses suits some patients. Somatose is believed to be useful. Thyroid extract, gr. j, three to five times daily, is said to improve the quantity and the quality of the milk. Inversion or retraction of the nipples should, as far as possible, have been rectified during the later months of pregnancy. Cracked or fissured nipples should be kept scrupulously clean, washed frequently with a saturated solution of boric acid, and anointed with cacao-butter over which a protective film of the compound tincture of benzoin may be applied. A well-fitting nipple-shield is often a great comfort when the act of suckling irritates the nipples. In the more severe cases the breasts may be drawn by means of a breast-pump and the milk given to the child with a spoon or medicine-dropper. Mastitis or mammary abscess generally renders the milk unfit food for the infant. Should the breasts become painful from over-distention, or should their increased weight produce irritation or disagreeable sensations, a compressing or supporting bandage may be applied. A wide roller-bandage properly applied will answer the purpose as well as a specially made breast-binder when the latter cannot be procured. Saline cathartics and moderation in the use of liquids will aid in diminishing over-distention from profuse secretion. Where the child is puny and does not draw enough milk to relieve the gland, the breast-pump may be made use of.

When for any reason it is proper that lactation be brought to an end during the puerperium, the application of a proper bandage to the breasts and moderation in the use of liquids generally answer every purpose. The woman will probably experience some pain in the breasts for several days, but this under ordinary circumstances soon subsides and the glands

undergo involution. Occasionally it may be necessary to give saline cathartics. Atropine and iodide of potassium are strongly recommended by various authors. Of the latter 5 to 15 grains may be given in water, carbonated water, or milk three times a day. Hirt prefers to give this drug in hot milk. The syrup of sarsaparilla, in which it is so frequently given, adds in no way to its efficacy, and the combination makes a nauseous mixture, which, strange to say, however, is not disagreeable to many patients.

The Visits of the Physician. The physician after the completion of labor should always remain within call until the uterus has firmly contracted and all immediate danger of hemorrhage has passed. He should see that the patient is as comfortable as possible, and so order arrangements that she will get the necessary quiet and refreshing sleep. The child's condition should have been examined into, and any defects in formation should have been noted. The umbilical cord should be inspected to make sure that it is in order and that the ligature has not slipped. Just before leaving the physician should give clear and distinct orders to the nurse in charge concerning the management of the woman and child. These may be put in writing if thought advisable. A visit should be made within twelve hours after labor, and at that time both mother and child should be examined carefully to see that all is going well. The physician himself should note the temperature, pulse, and respiration, keeping in mind the ease with which injurious distention of the bladder can occur and the fact that the passing of urine is often reported with a too full bladder and may simply mean an overflow (enuresis paradoxa). The state of the skin, the digestive apparatus, the amount and character of the food, the condition of the uterus and the lochia, must all be inquired into. The woman must not be allowed to become constipated. After the third day she should have a daily bowel passage. The condition and welfare of the child must not be forgotten. Inquiries must be made as to whether it has been fed or suckled, whether it is thriving and gaining weight or not, and about the conditions of its various functions. The nurse should be directed to keep for the reference of the physician a record of temperature, pulse, and respiration, of the bowel passages of both mother and child, and of the number of feedings of the child. Anything else which she may deem of importance for the treatment of the case should be duly reported. Temperature, pulse, and respiration should be taken three times a day for the first week; after that twice a day suffices. For the first week the physician should make a daily visit, after which time, providing the nurse be competent to care for the case properly, it will be sufficient to see the patient every second or third day. The patient should not be allowed to get up until the change is sanctioned by express order of the physician, and she must continue under his observation until convalescence is fully established.

Tardy Involution. When the progress of involution is abnormally slow it may be promoted by the use of friction, faradism, or small doses of ergot. Hot vaginal douching is useful, but this is a matter which can seldom be trusted to the nurse.

Friction is applied to the uterus by the nurse in the same manner as in the third stage of labor. The hand, laid flat on the abdomen, moves the abdominal wall with it in a circular direction over the anterior surface

of the uterus. The treatment is continued for ten or fifteen minutes twice daily.

Faradism may be applied through the uterus from side to side, the electrodes resting on the abdomen, or one on the abdomen over the uterus, and the other over the upper sacral region. The current need not be strong enough to cause pain.

Ergot in doses of ten or twenty minims three times daily is frequently of service.

A hot vaginal injection at a temperature of 48.8° C., 120° F. and repeated twice daily is effective. Douches, however, should, as a rule, be administered only by the physician and with extreme aseptic precautions.

A frequent cause of tardy involution, and which may pass unsuspected, is a mild infection of the endometrium. In such cases curetting is generally required. Curetting on this indication alone is seldom advisable earlier than the third or fourth week of the puerperium.

Displacement of the Uterus. The uterus sometimes becomes retroverted or retroflexed in the latter part of the puerperal month. This is most frequently the case in subinvolution, and particularly when retrodisplacement had existed before pregnancy. Evidence of the malposition will usually be afforded by pelvic tenesmus, by pain in the sacral region, and by return of the bloody flow. These symptoms are most marked on getting up. If on vaginal examination the diagnosis is confirmed, the uterus should immediately be replaced manually and supported by a suitable hard-rubber pessary. The pessary must be worn for two or three months. By the timely adoption of this treatment a permanent retroversion may almost invariably be prevented.

Pelvic Examination. It should be a routine practice to make a bimanual examination of the pelvic organs in the third or fourth week of the puerperium. The object is to determine the presence or absence of injuries of the vagina or cervix, the degree of uterine involution, and the possible existence of retrodisplacement of the uterus or other abnormal conditions.

The Diagnosis of the Puerperal State.

It is sometimes important for medico-legal or other reasons to determine whether or not a woman has been recently pregnant, or whether an abortion or labor at full term has lately taken place. In such cases the patient herself may be dead or, if living, may for various reasons deny absolutely the imputation of pregnancy, so that it will be left to the physician to determine from objective signs the true condition of affairs. Since the decision may involve serious consequences to one person or more, it is especially important not only that the report of the physician should be accurate, but that he may be able to bring forward proof which in the eyes of skilled witnesses may be considered irrefutable.

The evidences of a recent delivery may be divided into three classes: (1) positive, (2) probable, and (3) uncertain.

The Positive Signs of the puerperal state are derived from the ovum, and are only to be recognized by means of the microscope. The demonstration of placental tissue, especially chorionic villi, in a scraping or in a section taken from the uterus, is proof positive that the woman has been pregnant within a reasonably recent period.

The Probable Signs are numerous. The finding under the microscope of the so-called decidual cells, the much-enlarged cells of the uterine mucosa or decidua, is not absolutely conclusive, since very similar cells are found in certain cases of endometritis. Nevertheless the occurrence of these large cells, when found in conjunction with other probable signs, affords strongly presumptive evidence of a pregnancy. The same may be said of the abdominal striæ or lineæ albicantes, the contused condition of the genitalia, the presence of secretions resembling the lochia, the dilated smooth vagina, the soft and lacerated cervix, the enlarged uterus, and the swollen breasts with their well-marked areolæ and their secretion of colostrum or milk. These signs taken singly are not positive, since the occurrence of any one alone, or of several of them together, may be due to conditions other than pregnancy. The enlarged uterus, the softened and more or less lacerated cervix, the abdominal striæ, and at times even the milk-secreting breasts may all have had their origin in the previous presence and delivery of a large submucous uterine fibroid. It is only when a number of them are present at one and the same time that the proof of a preceding pregnancy may be said to be established beyond reasonable doubt.

The Uncertain Signs include the relaxed wrinkled condition of the abdominal walls, venous varices of the lower extremities, profuse sweats, and other less important symptoms. Such conditions are, of course, met with also in men as well as in women who are not pregnant. The relaxed, withered appearance of the abdominal walls may be due to the absorption or rapid disappearance of a large amount of fluid from a previous ascites or a large ovarian cyst. Mottled areas resembling the true striæ albicantes occur in people who have previously been stout and have subsequently lost flesh, and are due, as in the puerperal state, to the removal of the distention. Signs of this class, therefore, can only be regarded as affording confirmatory evidence of a condition indicated by those of the other categories. As regards the time that has elapsed since delivery, the condition of the lochia, of the vaginal wounds and the breast function must be taken into consideration. It must be remembered that placental and chorionic villi may be found in the uterus months after delivery has taken place. Our decision, therefore, on this point can never be more than approximate.

CHAPTER XI.

THE NEW-BORN CHILD AND ITS MANAGEMENT.

Anatomy and Physiology.

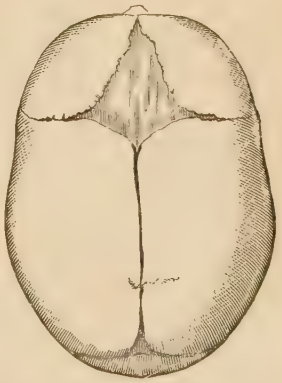
The normal infant is subject to variations in body-weight, length, pulse, respiration, mental development, secretion of urine, etc. A knowledge of these limits is necessary to a proper diagnosis of diseased states.

It may be stated in general that the thoracic and abdominal viscera of the infant are relatively more highly developed than the brain and generative apparatus. The bones are soft and flexible from the excess of animal matter and deficiency of calcium phosphate. The muscular structures are poorly developed, while the circulatory and lymphatic systems are relatively large. At birth the face is usually swollen and the features more or less distorted. The cranium is also elongated and out of shape, due to the pressure in the parturient canal during birth.

The shape of the head will depend on the presentation. In all cases where the occiput presents, the frontal portion is flattened and the occipito-mental diameter of the head is elongated. This distortion of shape soon corrects itself.

The Cranium. The cranial vault at birth is more or less plastic, owing to the fact that its bones are not fully ossified nor firmly united. The base of the skull is more unyielding than the frontal and parietal portions. The posterior fontanelle is usually nearly closed at birth, while the anterior generally remains widely open. The posterior fontanelle is usually imperceptible after six weeks. The anterior fontanelle appears to grow larger, after birth, until the ninth month, when it begins to grow smaller and should close from the nineteenth to the twentieth month. (Fig. 222.) The closure of the anterior fontanelle at birth, or soon after, is abnormal, and may indicate that the brain is abnormally small. When the anterior fontanelle is abnormally large, it indicates a lack of development of the bones or intracranial pressure.

Fig. 222.



Anterior and posterior fontanelles.

As the jaw is rudimentary, and the teeth absent, the facial part of the skull is relatively small. The ratio of the size of the face to that of the cranium at birth is about as 1 to 8, while in the adult it is about as 1 to 2.

The Spinal Column, at birth, consists mostly of cartilage with very little bone and hence is marked by great flexibility. The usual adult curvatures in the dorsal and sacro-coccygeal regions are but little developed in early infancy. The development and co-ordinating powers of the spinal muscles are feeble. It is usually several weeks before the infant can hold its head erect.

The Nervous System is imperfectly developed at birth. Although the brain is large, it is soft and presents no sharp distinction between the gray and white matter. The spinal cord is relatively in a higher stage of development than the brain, especially the anterior horns. The posterior and sensory portions of the cord are more immature. This explains the fact that motor manifestations are so active at this time, as sensory irritations and disturbances are quickly reflected into the predominant motor area. The rapid and irregular character of the muscular movements is evidence of this physiological fact. No act of volition takes place in the new-born, all movements at this period being automatic or reflex. Reflexes can be obtained after birth not only from the cutaneous nerves, but from the nerves of special sense—the optic, olfactory, and auditory.

Special Senses. The pupils of the eye may be unequal in size, but they react to light. The perception of light by the new-born is, however, imperfect, and the sense of sight, other than the ability to distinguish light from darkness, is not developed. Hearing is also imperfect, as the cavity of the tympanum is apt to be filled with fluid and the tympanic membrane is placed in a horizontal position. The senses of taste and smell are feebly developed at this time. The size of the peripheral nerves is relatively large, but their function is not active during the first few days after birth.

The Neck. The neck appears unusually short in the infant, although it is relatively longer than in the adult. This short appearance is due to a large head which falls forward and partly covers the neck, the high position of the sternum and the large amount of subcutaneous fat. The larynx is placed much higher than in later years.

The Trunk at birth is nearly egg-shaped, with the smaller end above and the larger at the bottom. The thorax is small in comparison with the abdomen, owing to the disproportionate development of the liver in fœtal life. The shoulders are poorly developed as are also the lungs.

The Thorax. The thorax is of small size in the new-born, the circumference being a little less than that of the head. The cavity is shallow in its antero-posterior diameter, the distance from the vertebral column to the manubrium being so small that compression may be induced by enlarged lymph-glands. The sternum at birth is practically a strip of cartilage in which a varying number of bone-centers have been deposited. It is therefore very flexible and accommodates itself to the size and shape of the thoracic organs. There is a widening out, relatively great, toward the base of the cavity. The ribs are soft and elastic, being inserted in a rectangular and horizontal direction, which renders the respiration almost entirely abdominal. The intercostal muscles are thin and they exert little action on the ribs. The first dorsal vertebra is on a level with the upper margin of the sternum, at birth, but later the second dorsal vertebra assumes this position.

The Lungs. Just before birth the unaërated lungs lie in the posterior part of the thorax on either side of the pericardium. Immediately after birth several deep and spasmodic inspirations should quickly inflate the lungs, which then assume a pinkish color. The lungs of an infant differ from those of the adult in that the extent of the bronchial tubes is greater than the air cells. The connective tissue about the bronchi is in greater abundance, supplied with a greater number of nuclei, and the blood vessels are less firmly held together. The alveoli are small, their epithelial cells form a continuous layer and proliferate rapidly. The absorbents are poorly developed and absorb slowly. The blood vessels are obliged to assume the rôle of absorbents. These facts are important in the production and cure of broncho-pneumonia.

Respiration. The number of respirations per minute immediately after birth is about 44. During the first month it is 36 to 24, and from the second to the fifth month from 32 to 25. The character of the respirations in young infants is diaphragmatic or abdominal, and during the first few weeks is irregular both as to frequency and depth. Infants on the breast exhale about 13.5 Cc. of CO_2 per square metre of surface, while adults exhale about 16 Cc. per square metre of surface.

The Heart. The heart in the new-born infant is relatively wide because of the development of the right ventricle during fœtal life. The apex beat is thus thrown upward and outward and will be found at or outside of the mammary line. The changes taking place in the heart and circulation at birth (see page 96) are not simultaneous and occasionally are greatly delayed or do not all occur. The heart may therefore remain defective. The size of the heart in the new-born is large as compared with the rest of the body. According to Gray, this ratio is as 1 to 120 at birth, while in the adult the average is about 1 to 160. The arteries are also relatively large in comparison with those of the adult, and the arterial pressure is small in young infants. The heart acts quickly and somewhat irregularly in the new-born, the pulse-rate varying from 125 to 140 or 150. The rhythm of the pulse in infants is irregular as to interval and is often dicrotic. The pulse is subject to more variability under slight influences than in the adult.

The Blood. Upon ligation of the umbilical cord and the cessation of the placental circulation, important changes follow, not only in the infant's circulation, but also in the blood itself.

These changes appear to be first of a degenerative nature, and they are consequent upon a more perfect oxygenation of the blood. Immediately after birth the red corpuscles number six or seven millions per cubic centimetre, while by the fourth or fifth day the number has dropped to four or five millions. The size of the red corpuscles at birth is likewise variable, and the white corpuscles are present in much greater proportion than in the blood of the adult, constituting a genuine hyperleucocytosis. The amount of blood in the new-born is less in proportion to the body-weight than in older subjects. The quantity of blood immediately after birth will vary somewhat according to the length of time during which connection with the placenta is maintained. Just after birth, there is comparatively little fibrin in the blood, hence a certain slowness of coagulation. Cephalhæmatomata are slow in solidifying, and meningeal apoplexies are apt to spread over the surface of the brain as a result of this

condition of the blood. Its specific gravity is also somewhat lower than in later years.

Temperature. The rectal temperature of the new-born infant is from 99° to 100° F. Crying, fright, or other excitement may raise the temperature from one-half to several degrees. It is also subject to very considerable variation as the result of disturbances in the nervous or digestive systems. The temperature of infants is on this account unreliable as a symptom of disease.

The Digestive Organs. A peculiarity of the mucous membrane of the mouth in the new-born consists in its thinness and the frequent existence of minute gray patches of epithelium on the median line of the palate, the so-called "epithelial pearls."

The Stomach. The stomach is small, with more of a vertical than a horizontal inclination, the fundus being absent. It is little more than a simple expansion of the digestive tube. Vomiting is easily performed in early life by a sort of regurgitation, without nausea, produced by contraction of the muscular fibres in the stomach wall. The capacity of the stomach of the new-born child rapidly increases during the first three months, then very slowly for about three months, and then it increases steadily until the adult size is reached. The capacity increases, as a general rule, with the weight of the infant. There are some exceptions to this rule, however, in those infants who are artificially fed and who do not gain weight in a normal manner. Overfeeding may dilate the stomach to a very large extent, so that its capacity may be much out of the natural ratio to the weight. Underfeeding, on the other hand, may allow the stomach to contract. These facts have a very important bearing upon the practice of artificial feeding, and should not be lost sight of.

The capacity of the stomach

At birth is about	25–30 Cc. or 1 oz.
At the 4th week about	75 Cc. or 2½ oz.
At the 8th " "	96 Cc. or 3⅛ oz.
At the 12th " "	100 Cc. or 3½ oz.
At the 16th " "	107 Cc. or 3¾ oz.
At the 20th " "	108 Cc. or 3⅞ oz.
At 6 months "	150 Cc. or 5 oz.
At 9 months "	200 Cc. or 6⅔ oz.

These measurements of the capacity of stomachs of normal breast-fed infants do not always apply to the bottle-fed infants, whose stomachs will very frequently hold and digest larger quantities of food than these figures indicate. Over distention of the stomach with fluids is usually followed by regurgitation.

The Intestines. *The small intestine* is not uniform in length at birth, but measures about nine feet, while the large intestine measures not quite two feet. During the first and second months after birth the small intestine grows about two feet in length each month. After that the growth is irregular, probably varying with the character and amount of the food.

The large intestine, at birth, is nearly one half composed of the sigmoid flexure. During the first three or four months the large intestine does not increase much in length, but the colonic part grows at the expense of the sigmoid portion. The cæcum is placed higher in the infant and is more movable than in adults. The vermiform appendix is relatively longer than in adults. The sigmoid flexure is relatively long and tor-

tuous in infants and this with the descending colon is much more freely movable than in adults.

Feces. The intestinal contents at birth consist of a very dark greenish-black pasty mass called meconium. This is discharged during the first three to five days, when the normal lemon-yellow milk stools make their appearance. In weakly infants who do not nurse well, the dark color of the discharges may continue for a week. During early infancy a normal infant usually has from two to four evacuations daily. They should be golden-yellow in color, smooth, pasty in consistency, free from milk curds, and acid in reaction. They may become greenish-yellow on exposure to the air.

The Liver. The liver at birth is of relatively large size, being greater in bulk than both lungs, and containing much blood. The large size and importance of the liver in fœtal life will be understood by considering it a sort of intermediary organ between the placenta and the general circulation, as far as the re-oxygenated blood is concerned. At birth the communication between the placenta, the liver and portal vein, by means of the umbilical vein, is severed by cutting the cord. The lungs at once inflate and assume the respiratory function. The umbilical vein begins to shrink, and is completely obliterated between the second and fifth days of life. It is finally reduced to the fibrous cord known as the round ligament of the liver. The ductus venosus is usually obliterated within a few days after birth. Although the liver has now lost its preponderating importance in the economy, it still remains relatively larger and heavier than in later life. The diminution of the organ is due to its altered blood supply, and is especially marked in the left lobe. The relative decrease in its weight that begins at birth continues from infancy to old age.

The *digestive juices* are imperfectly secreted in the new-born. Saliva is present in some degree, with slight amylolytic power; there is not much saliva secreted in the first three or four months, and of this, little reaches the stomach. It plays but a slight rôle in digestion. The gastric juice is fairly active, but the pancreatic secretion does not attain physiological potency for several weeks. The intestinal glands are likewise in a low stage of development, but the intestinal secretion contains invertin, lactase, secretin, erepsin, and enterokinase. The bile is poor in cholesterin, lecithin, fat, the bile acids, and in inorganic salts, and has little effect in checking intestinal fermentations, owing to the deficiency of bile acids. It is, hence, not difficult to understand the feeble digestive powers of early infancy, and the necessity for the greatest care in the administration of nutriment.

The Urinary Organs. The pelvis is shallow; its inclination is exaggerated, and its capacity is small. The bladder is largely an abdominal organ.

The Bladder. The bladder, when distended, is oval or egg-shaped in form, without a marked fundus, and it lies principally in the abdomen. The muscular wall is relatively very thick and dense, so that in female infants the bladder may be mistaken at an autopsy for the uterus. In the female the urethra is placed along the anterior wall of the vagina, and its meatus appears almost as large as the orifice of the vagina. Confusion is sometimes encountered in passing a catheter unless this fact be borne in mind.

The Kidneys. The kidneys are embedded in loose, fatty tissue, low down in the abdominal cavity, covered only in front and on their external borders by peritoneum. They are relatively of large size, and are distinctly lobulated. Crystals of uric acid often form in the calices and in the pyramidal portions of the kidney during the first few days of life, and may produce considerable disturbance by their presence. The suprarenal glands are also of large size, sometimes completely covering the kidneys.

The Urine. The kidneys begin to secrete urine early in fœtal life. The bladder is often full at birth. Little urine is secreted during the first twenty four hours after birth, the first secretion being dark and strongly acid. Later it becomes light colored and of low specific gravity, 1003 to 1006, and usually contains uric acid crystals and acid sodium urate. The inorganic salts are low in amount. Albuminuria is common in infancy and sugar (lactose) is frequently found during the first two months. The amount of urine secreted after the first few days is larger, per pound of body weight, than in adults.

The following table from Reusing gives an idea of the amount of urine and of urea passed by an infant during the first week:

	Breast-fed.		Bottle-fed.	
	Urine.	Urea.	Urine.	Urea.
First day	8.4 Cc.	0.060 grms.	35.0 Cc.	0.330 grms.
Second "	26.8 "	0.260 "	71.0 "	0.400 "
Third "	40.9 "	0.520 "	135.0 "	0.670 "
Fourth "	60.8 "	0.500 "	187.0 "	0.650 "
Fifth "	119.1 "	0.780 "	283.0 "	0.650 "
Sixth "	157.0 "	0.790 "	325.0 "	0.615 "
Seventh"	208.0 "	0.810 "	406.0 "	0.880 "

It will be seen that the amount of urine passed is greater in bottle-fed than in breast-fed infants. The larger amount of urea excreted by the latter during the first few days is probably due to the fact that more food is given in bottle-fed than is supplied to breast-fed infants during these days. The composition of the food has an important influence upon the quantity of urine and urea excreted. Malted foods and foods containing an excess of maltose, lactose, or water increase the amount of urine. Uric acid infarctions are usually found in the kidneys, reaching the maximum on the second day and disappearing after the sixth day. The uric acid is relatively greater in the urine of the first few days than in adult urine, and greater than in the later weeks or months. The rose colored stains often seen on diapers of new-born babies usually consist of uric acid. Hyaline and epithelial casts are frequently found in the urine of the new-born infant.

The Skin. The skin of the new-born infant is soft and red, and covered with a growth of short, very fine hair, called *lanugo*, which is shed during the first few weeks. The sebaceous are more active than the perspiratory glands. At birth the entire body is covered with sebum of a cheesy consistency, called the *vernix caseosa*, mixed with epithelial cells and lanugo.

The Lymphatics. The lymphatics are abundant, of large size and more active in the infant than in the adult. Owing to their activity they are especially liable to disease and infections. Enlarged lymph-nodes are common in infancy and childhood, and in debilitated and diathetic conditions are liable to break down and suppurate, especially in certain locations, as in the cervical region.

Body Weight and Development. The average weight of a normal male infant is about 7¼ lbs. and of a female infant 7 lbs. There is usually a loss in weight during the first three or four days after birth of from 6 to 8 ounces, which is regained during the second week. After this time there should be a steady increase in weight of about three ounces during the second week, four ounces during the third week, five ounces during the fourth week and after that the gain should be from 6 to 8 ounces per week. (See Fig. 229.)

The average length of a male infant at birth is about 19.75 inches (50 cm.) and of females 19.30 inches (49 cm.).

The average length and weight of normal infants at birth, at six months and at one year of age is as follows:

	Boys		Girls	
	Height	Weight	Height	Weight
At birth	19.7 in.	7.3 lbs.	19.3 in	7.1 lbs.
At 6 months	25.4 "	16.0 "	25.0 "	15.8 "
At 1 year	28.0 "	21.4 "	27.6 "	21.0 "

As the weight of an infant is by far the most reliable single symptom by which to judge of its nutrition and good health, careful weighing at weekly or bi-weekly intervals should be insisted upon as an important part of its care and management during the first year. By this means, even the slightest deviations from health may be detected, and serious illness may be warded off.

Normal Development. The height and weight are not the only means by which the normal development of an infant may be determined. We make use of the development of various other functions to determine the state of development, as sight, hearing, facial expression, ability to hold the head up, to sit alone, to walk, to talk, to distinguish strangers from its mother, and the time at which the teeth appear.

A normal infant should hold up its head without support at the third month, recognize a familiar face at about the same time and show pleasure at the sight of playthings at the fourth month. It should sit alone at about the seventh month, stand with the aid of holding to some object at the tenth month and walk at the twelfth or fourteenth month. The lower incisors should appear at the seventh month. Rickets or malnutrition will delay the time of walking and of the eruption of the teeth.

MANAGEMENT.

Respiration. The first duty of the attendant, after delivery, is to see that respiration is established. The mouth should quickly be cleansed of mucus or blood, and the infant placed on its back or right side. If it does not breathe at once, respiratory efforts may be provoked by such simple measures as blowing on its face, a few smart taps with the hand upon the buttocks, or sprinkling with cold water. If the child draws three breaths during the first minute, it may usually be left to itself. Should it still fail to breathe, examination is made to see if the heart is pulsating. If it is, the cord is severed and artificial respiration maintained as long as the cardiac pulsations can be felt, or until regular spontaneous respirations are established. For the methods of performing artificial respiration, the reader is referred to the Treatment of Asphyxia of the New-born.

Ligation of the Cord. As soon as respiration is established, the cord, in the absence of navel cord hernia, is firmly ligated at a distance of about one-half to one inch from the cutaneous line. The ligature should be aseptic, strong, and of sufficient size to prevent cutting into the walls of the vessels. The cord is then cut with sterile scissors, about one-half inch from the ligature, on the placental side. It is unnecessary to apply two ligatures and cut the cord between them, as is sometimes recommended, except in case of twin births. By allowing the blood to escape from the placenta its volume is reduced and its delivery rendered easier. If, however, the bleeding from the cut end of the cord should be profuse, and continue for a considerable time, it is best to tie it. When the cord is unusually large, a part of the gelatinous portion may be stripped away, lest it retard desiccation, and by shrinkage loosen the ligature. If the first ligature does not entirely arrest the oozing of blood from the cut end of the cord, another should be applied nearer the body.

Examination of Child. Before the bath, a careful inspection of all parts of the body should be made to detect possible malformations. This should include the head, mouth, neck, chest, abdomen, spine, joints, anus, and genital organs. A rectal injection may be employed to make sure that the rectum is pervious. Any limitation to the free movement of the joints should receive careful attention, lest a dislocation, especially of the hip or shoulder, should be overlooked.

The Bath. The child is now wrapped in a previously warmed blanket or flannel. If much time has been consumed in establishing respiration, it will be well to place it in a basin of warm water for a few minutes, to warm its extremities and stimulate its circulation, before wrapping in the blanket. The water should not be warmer than 100° F. Care should be used to avoid too much exposure of the new-born infant during the first few hours of its life. If its circulation is feeble, or if it seems weak or chilly, the first bath should be postponed, and its body heat be conserved by wrapping in cotton, with a shawl or blanket outside of this. Usually the cleansing may be proceeded with, should be done as quickly as possible, and should be done in a warm room. During the process the infant should be protected from exposure. The sebum can easily be removed by covering the skin with a bland oil, such as sweet oil, lard, or vaseline, applied with the hand. Gentle friction may be necessary when the cheesy mass is tenacious. When the whole body has been freely and systematically anointed, the surface may be cleansed with soap and water; finally, the infant is immersed in water at a temperature of about 95° F. It is then enveloped in a large towel and dried. Great care should be observed in thoroughly cleansing the eyes and mouth. For this purpose a nearly saturated solution of boric acid in water may be used. The eyes are to be thoroughly cleansed of all vaginal secretion by allowing the solution to drop from absorbent cotton that has been saturated with it. After this irrigation, small masses of matter still adhering may be removed by mopping the lids with the cotton. A careless and free use of soap is sometimes responsible for irritated or inflamed eyes. The mouth may next be gently washed out with a soft rag wet with the boric acid solution.

Care of the Cord. The stump of the cord, after being cleansed and

dried, should have an extra ligature applied if required for safety, be dusted with boric acid or other antiseptic powder and then wrapped in absorbent cotton or antiseptic gauze. Mummification and protection of the stump from infection or injury is the chief object of the navel dressing. The application of oils to the stump is to be omitted, since these agents tend to prevent a rapid desiccation. The stump when dressed is laid flat on the abdomen with the cut surface directed to the left, and kept in place by the ordinary belly-band. The stump usually separates in from four to seven days. When this occurs, a small superficial ulcer is left that should soon heal. This also is to be kept dry, and may be dusted with boric acid and covered with sterile gauze.

Sudden Deaths. It should be remembered that new-born infants are liable to sudden and unexpected death. It is not uncommon for an infant apparently doing well to suddenly die, with or without convulsions. The most common causes of sudden death are the following:

1. Acute bronchitis or broncho-pneumonia with heart failure.
2. Cerebral hemorrhage, with or without eclampsia.
3. Acute indigestion with autointoxication, with resultant eclampsia.
4. Asphyxia, caused by vomiting and aspiration of vomited matters into a bronchus, or from laryngeal spasm.
5. Congenital weakness, as in cases of hereditary syphilis, premature birth, etc.
6. Nephritis, septicæmia, anomalies of the brain or cord, congenital cardiac malformation or atelectasis.
7. Status lymphaticus, as from enlarged thymus or other gland.

Other causes may give rise to sudden death but the above are those most often met with. The fact that such an accident is liable to occur should cause the attendant to carefully watch a new-born infant.

The Clothing. After the bath the child is dressed. The belly-band may consist of light merino in summer and soft flannel in winter, reaching from the axillæ to the hips. It should not be applied so tightly as to embarrass the movements of respiration. No general rule need be given in respect to the exact amount and character of the clothing. Two things, however, are essential: It should be sufficiently warm, as tested by feeling the child's hands and feet, and it must be loose enough to allow free play for movements of the hands and feet and for respiration. During sleep, the sides of the head and the neck and shoulders may be covered with a light shawl. It is, however, unnecessary if not harmful to cover the face so as to interfere with a proper supply of fresh air.

Maternal Nursing. After the mother has rested for six or seven hours, the infant may be applied to both breasts. This helps to establish the habit of suckling, and stimulates the mammary glands and the uterine contractions in the mother. *No other food should be permitted when the infant is able to nurse its mother.* It should be remembered that the new-born infant is unprepared for digestion, and feeding is likely to do harm.

If there are reasons why the child should not be put to the breast at this early period, a teaspoonful of warm sterile water may be given at intervals of an hour or two if it is restless. The administration of water as a routine practice is useful for flushing the kidneys.

The mother, as a rule, should nurse her own infant. Natural nursing,

for the first nine months, is so essential to the child's well being, especially in large cities, that nothing short of necessity should prevent it. Rarely, malformations of the nipples, depressed or retracted nipples, or extensive fissures may make nursing difficult or impossible.

To obtain the best results the greatest possible regularity in nursing must be observed. The child should not, as a rule, be allowed to nurse oftener than once in two hours during the day, and in four hours during the night. In its own interest and that of its mother, the infant should not sleep in the bed with the mother, but in a crib. It is important for the mother's health, as well as for the quality of her milk, that she have seven or eight hours of sleep at night.

One of the commonest causes of trouble in maternal nursing arises from nursing the infant whenever it cries, for the purpose of quieting it. This is one of the most frequent sources of acute and of chronic infantile indigestion. Violent emotional paroxysms on the part of a nursing mother may so modify the milk as to produce acute indigestion or severe nervous disturbance in the infant. Fretfulness, convulsions, acute diarrhœa, collapse, and even death, have been known to result from this cause. Colic and indigestion in the infant are sometimes due to digestive derangements of the mother.

The infant should suckle the breast for about fifteen or twenty minutes at each nursing, and then fall asleep. If it is unsatisfied and fretful after nursing for that length of time, there is probably insufficient milk in the breast or indigestion in the child. The breasts' milk may fail either in quantity or quality. If too little is secreted, stimulation of the gland and a generous diet are indicated. The most natural stimulation comes from the application of the infant at comparatively frequent intervals; a long interval is sometimes allowed with the mistaken idea that rest may enable the gland better to fulfil its functions.

A generous supply of nourishing and easily digested food is indicated. Oat- and corn-meal gruels, thin and well cooked, have a reputation for promoting the milk secretion which seems to have some foundation in fact, although extended experiments seem to indicate that the chemical composition of the milk is but slightly affected by the character of the food, provided a liberal supply be taken. A diet rich in proteid matters usually increases the per cent. of fat in the milk, but not the proteids. The liberal use of cow's milk has a like effect. Malt liquor, such as ale or porter, by stimulating the appetite, may indirectly aid the production of milk. Temesvary experimented upon 216 nursing women with different diets, and reached the following conclusions:

1. A rich mixed diet gives the most milk and the greatest absolute amount of fat.

2. The ordinary diet is the next best, while a purely vegetable diet gives the poorest milk.

3. The total solids follow the fat, in absolute amount, in 24 hours.

4. Beer (three fourths litre) added to a liberal mixed diet lessened the quantity of milk, and slightly increased the relative and absolute amount of fat. Beer added to a rich diet gave the most rapid increase of weight of the infant. It seemed to have little effect on the milk or the infant, when added to a vegetable diet.

The digestion and assimilation of the nursing mother often suffer for want of proper exercise, with the effect of impairing the quality and lessening the quantity of milk. Regular exercise in the open air must be advised as soon as circumstances permit.

It must not be forgotten that the mammary gland may act as an excretory as well as a secretory organ. This is especially true at the beginning of the lactation period, when great care must be exercised in giving drugs that may be excreted in the milk and affect the infant. Alcohol, opium, and belladonna are known to be thus eliminated in amounts sufficient to produce appreciable effects upon the infant.

Contraindications to Maternal Nursing. Most mothers prefer to nurse their offspring, and the physician should encourage adherence to the natural method of feeding in the absence of a definite contraindication. The following are the conditions which most frequently prevent or forbid nursing:

1. Depressed, or otherwise deformed nipples;
2. Diseases of the nervous system in general;
3. Epilepsy, when the seizures come oftener than twice a year;
4. Hysteria, especially after a pronounced hysterical disturbance;
5. Certain constitutional diseases, such as tuberculosis or syphilis;
6. Chronic diseases of the skin, such as eczema, prurigo, psoriasis, etc.;
7. Caries and chronic joint diseases;
8. Chronic rheumatism;
9. Advanced cardiac or renal disease;
10. Puerperal fever continuing more than two or three days;
11. Metrorrhagia when prolonged, since it has a very deleterious effect upon the composition of the milk. The appearance of the regular menstrual flow is not a contraindication to nursing unless the child shows signs of disturbance at the epochs;
12. Pronounced anæmia not easily corrected by treatment;
13. Abnormal milk, when it disturbs the digestion of the infant, and when it cannot be corrected by changes in the mother's diet or faulty habits.

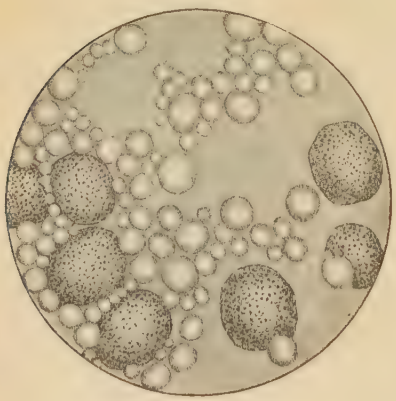
Mother's Milk is a secretion of the mammary glands, consisting of an emulsion of fat and casein suspended in a clear transparent liquid, in which sugar, lactalbumin, certain extractive matters and inorganic salts are dissolved. A good normal mother's milk has a bluish-white appearance, is more transparent than cow's milk, and has a sweeter taste than the latter. It is neutral or slightly alkaline, frequently amphoteric in reaction to litmus and has a specific gravity of 1026 to 1036. When examined under the microscope, the milk globules will be found to vary greatly in size; each is surrounded with a layer of more or less viscid material, which prevents them from running together. According to Woll, 1 Cc. contains 1.6 million globules, from 0.0024 to 0.0045 mm. in diameter.

Colostrum. The fluid secreted by the mammæ during the first three days after the birth of the child is called colostrum. It differs materially in composition from the true milk secreted later. It contains more proteid matters, less fat, and less sugar than milk. The amount of proteid varies greatly in different cases, from 2 to 8 or 9 per cent. We may take 2 to 3.5 per cent. as a fair average of the proteids during the first

three days of lactation. The proteids of colostrum are made up largely of albumin and globulin instead of casein, and hence the liquid coagulates on boiling, while true milk does not. The fat of colostrum begins at about 2.5 per cent., and rises rapidly to 3.5 per cent. The sugar begins at about 5 per cent., and rises rapidly to 6.5 per cent. by the end of the second week.

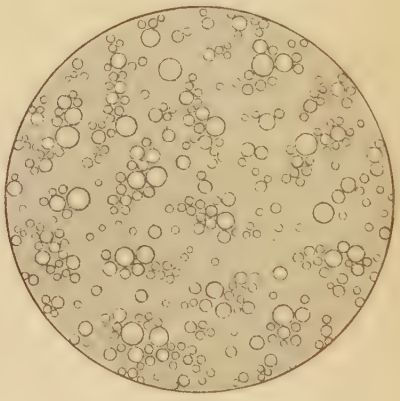
During the first eight or nine days after parturition, and sometimes later, the milk contains characteristic larger bodies, known as colostrum corpuscles. These appear to be composed of masses of protoplasm containing fat. The colostrum corpuscles are four to five times as large as the fat globules. (Fig. 223.) They may occur in milk at any later time during the lactation period, and are then to be regarded as evidence of illness in the mother, or of pregnancy. Occasional colostrum corpuscles in the milk have little or no significance, but if present in considerable number they are liable to cause digestive derangement in the infant.

FIG. 223.



Colostrum corpuscles.

FIG. 224.



Normal human milk.

Normal Human Milk. Normal milk, under the microscope, has the appearance seen in Fig. 224. In taking a sample of milk for microscopic examination, it should be drawn after the child has about half emptied the breast, and not at the beginning or end of the nursing. The microscope is often of value in showing the presence of leucocytes, colostrum corpuscles, blood, pus, or other foreign elements, but it is of little value as a guide to the richness of the milk, on account of the difficulty in securing a sample that represents the average secretion of the glands. The centrifuge should be used to separate the cellular elements for microscopical examination. The length of time the milk has remained in the mammæ exerts an important influence upon the number of globules it contains. The longer the period of retention the more watery it becomes, probably from absorption of the solid constituents. On the other hand, milk that is frequently taken from the breast is thicker from being richer in fat.

Abnormal Mother's Milk. It occasionally happens that an apparently

healthy mother secretes a milk that disagrees with the infant. The constituents most subject to variations are the fat and proteids. When the normal ratio of the fat and proteids (2.5 to 1) in the milk is preserved, wide variations in their absolute amounts will usually be tolerated by the infant. When the fat is low and proteids high, or when the fat is high and proteids low, the milk is very liable to disagree with the infant. Our knowledge of the causes of these variations is, unfortunately, imperfect. Rotch and Adriance find that a diet rich in nitrogenous matter tends to increase the fat in the milk, while an abundance of fat in the food tends to diminish it. Excess of proteids is usually more troublesome than any other abnormality. Rotch also pointed out that an over-liberal diet, with little exercise, may increase the proteids in the milk; a less generous diet, with abundant out-door exercise, may correct this abnormality. Marked emotional disturbance frequently increases the proteids temporarily and causes colic in the nursling.

Infants will sometimes thrive on a mother's milk that is apparently abnormal so far as analysis can show. This is shown in the following nine analyses by Harrington of milks upon which the infants were well and thriving:

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Fat	5.16	4.88	4.87	4.37	4.11	3.82	3.80	2.96	2.09
Sugar	5.65	6.20	6.10	6.30	5.90	5.70	6.15	5.78	6.70
Proteids . . .	4.14	3.71	4.17	3.27	3.71	1.08	3.53	1.91	1.38
Ash	0.17	0.19	0.19	0.16	0.21	0.20	0.20	0.12	0.15

The following table contains the analyses of Carter and Richmond of human milks upon which the infants sickened:

Fat.	Sugar.	Proteid.	Ash.	*Notes.*
2.94	5.78	4.05	0.28	Child died.
4.13	4.80	3.11	0·48	" "
1.22	8.89	1.55	0.33	Child failing.
3.28	5.60	1.76	0.27	Vomiting.
3.33	6.63	2.06	0.26	"
3.37	6.72	1.95	0.25	"
3.95	5.40	3.19	0.34	Diarrhœa and vomiting.
2.36	7.03	1.50	0.23	Child failing.
2.66	6.03	1.64	0.27	" "
0.89	5.19	4.02	0.38	Child died.
1.87	5.75	2.65	0.35	" "
0.89	5.35	3.16	0.37	" "
2.10	6.55	2.54	0.36	" "
3.70	5.53	2.05	0.36	" "
4.71	4.87	1.47	0.38	" "
3.43	6.42	2.48	0.32	Diarrhœa and colic.
2.16	6.70	2.52	0.33	" "
0.81	6.50	2.83	0.33	Colic, diarrhœa and vomiting.
1.48	6.45	2.79	0.33	" "
0.98	6.52	1.71	0.20	Supply deficient.
4.07	6.31	1.77	0.20	" "

When we examine these tables of analyses we must admit that it is very difficult to define abnormal breast milk from a chemical standpoint. Harrington's table demonstrates the great elasticity of an infant's powers of digestion, and the great variability of human milk.

When there is reason to believe that the mother's milk is not agreeing with her infant, an excess of casein should be suspected, and an analysis by a chemist may reveal the fault if it lies in the milk, and point out the way to its correction. It is advisable in all such cases to examine carefully into the mental and physical habits and characteristics of the mother.

The following table of variations in human milk, from Rotch, is of interest in this connection:

	Normal. Normal exercise and food.	Poor. Starvation.	Very rich, Generous diet. Little exercise.	Bad Milk. Pregnancy. disease, etc.
Fat	4.0	1.50	5.10	0.80
Proteids	1.2	2.40	3.50	4.50
Sugar	7.0	4.00	7.50	5.00
Ash	0.2	0.09	0.25	0.09
Total solids	12.13	7.99	16.35	10.39
Water	87.87	92.01	83.65	89.61
	100	100	100	100

Daily Quantity of Milk Secreted. The daily amount of milk secreted by the average mother, and the weight of each feeding and of each constituent at different periods of lactation, are given in Table I. (page 290), from Pfeiffer. The results were obtained by weighing a series of infants before and after each nursing, and adding the weights of all the feedings for the twenty-four hours. The weights of each constituent were obtained by calculation from the composition of the milk as determined by chemical analysis.

Variations in Quantity and Composition of Human Milk. It will be noted that the quantity of milk secreted increases gradually from the beginning of lactation until about the tenth week, then remains practically stationary until the sixth month, when it increases somewhat, and finally decreases. Human milk varies considerably, both in quality and quantity, in different individuals, and even in the same individual, because of varying physiological and pathological conditions relating to food, nutrition, duration of lactation, length of time the milk remains in the breast, exercise, menstrual function, emotions, and nervous affections.

TABLE I.

Age of infant.	Total amount in grammes.	Number and weight of each meal.	Proteids in grammes.	Fat in grammes.	Sugar in grammes.
1 month.					
½ week	104	8 × 13	4.40	2.81	4.69
1 "	254	7 × 36	8.74	6.86	11.44
2 weeks	334	7 × 48	7.64	12.13	15.05
3 "	449	7 × 68	10.27	12.13	20.23
4 "	550	7 × 71	12.58	17.86	24.78
2 months.					
5–6 weeks	749	7 × 107	13.82	22.52	41.47
7–8 "	864	7 × 123	15.83	26.40	45.03
3 months.					
9–10 weeks	926	7 × 132	17.68	20.43	55.28
11–12 "	896	7 × 128	17.10	20.25	53.50
4 months.					
13–14 weeks	966	7 × 138	19.53	39.02	59.12
15–16 "	974	7 × 139	19.62	39.23	59.39
5 months.					
17–18 weeks	996	7 × 142	17.38	52.36	
19–20 weeks	996	7 × 142	17.42	52.28	
6 months.					
21–22 weeks	1023	6 × 167	15.82	26.88	60.00
7 months.					
25–28 weeks	1051	6 × 174	15.99	31.77	60.40
8 months.					
29–32 weeks	741	6 × 124	12.15	28.69	42.80
9 months.					
33–36 weeks	482	6 × 88	7.26	11.62	28.94

Analyses of human milk by different chemists differ so widely that it is difficult as yet to determine the typical normal standard. In general, it may be stated that during the first week of lactation colostrum is secreted, containing less fat and sugar than normal milk, more proteids (the greater part of which is lactoglobulin and lactalbumin), and more salts.

The fat and sugar rapidly increase after the third day till the end of the first month; from that time the proportions of these ingredients remain constant until about the eleventh month, when they fall off. The proteids and salts exist in much larger percentages in colostrum than in normal milk, the former containing on an average 2.5 to 3.5 per cent. of proteids and 0.4 to 0.5 per cent. of salts. Both these constituents gradually diminish until the eleventh month, when they again slightly increase. During the first month of lactation, human milk contains between 1.5 and 2.5 per cent. of total proteids; during the second about 2, and in the third about 1.5 per cent.

The percentage of iron falls off as lactation proceeds, and after the eighth or ninth month it becomes decidedly less than normal. The milk of the early months of lactation, then, is characterized by a large percentage of proteids and salts, and a small percentage of sugar. That of the later months is characterized by a smaller percentage of proteids and salts, and a higher percentage of sugar. The smaller proportion of proteids and of iron in the later months contraindicates prolonged nursing. When children are nursed too long (beyond the eleventh month) they frequently show symptoms of malnutrition, and often become anæmic or rachitic.

It is of interest to note that the composition of milk varies greatly, according to the time it has remained in the mammæ. Foster gives the following analyses of the first, the middle, and the last portion taken from the breast during an ordinary nursing.

	First portion.	Second portion.	Last portion.
Amount taken	33.1 c.c.	33.1 c.c.	37.3 c.c.
Water	90.24 per cent.	89.68 per cent.	87.50 per cent.
Proteids	1.13 "	0.94 "	0.71 "
Fat	1.70 "	2.77 "	4.51 "
Sugar	5.56 "	5.70 "	5.10 "
Ash	0.40 "	0.32 "	0.28 "

It is evident from the foregoing figures that care must be observed in obtaining a sample of milk for analysis, if we wish to secure results that are comparable or that will represent the real composition of the secretion. The middle portion only should be taken, after the child has nursed one-third of its usual time. These analyses also show that in too frequent nursing the child gets only "strippings," or over-rich milk, likely to disturb digestion.

Substitute Feeding.

Wet-nursing. When, after persistent effort, the mother is unable to nurse her infant, wet-nursing may be considered. So difficult is it to secure a good wet-nurse that the uncertainties of this method are often scarcely less than those attending artificial feeding. The expense, too, of substitute nursing places it beyond the reach of the masses.

The moral character and social standing of most women who are willing to wet-nurse are such that many families shrink from taking them into their homes. While the danger of the transmission of syphilis or tuberculosis by an apparently healthy nurse has been overestimated, it is, nevertheless, a real one, and no woman the subject of either of these diseases should be allowed to nurse an infant. There are many instances on record in which syphilis has been communicated in this way.

While healthy breast milk is undoubtedly the best food for an infant, it is equally true that with a proper knowledge of the best modern methods of artificial feeding there is now little need of resorting to wet-nursing.

Mixed Feeding. It frequently occurs that the mother is able only to partially nurse her baby. In such cases mixed feeding should be resorted to—*i. e.*, the mother should nurse the infant at regular intervals, and the nursing should be supplemented by two or more artificial feedings in the twenty-four hours. The practice of nursing only at night, which is sometimes advised, is objectionable. Regularity of nursing is essential to the continuance of the secretion. Mixed feeding may sometimes be rendered necessary by the transient illness of the mother, or by a temporary deficiency occasionally resulting from unassignable causes, or from nervous or emotional influences. In some instances the secretion may be restored by faradization of the breasts or by change of surroundings.

Artificial or Bottle Feeding. When good breast milk is not available, artificial food must be provided, and its preparation must be managed with scrupulous care. When it becomes necessary to practise artificial feeding from birth, we may, with advantage, use whey made from cows' milk for the first few days. For this purpose the whey should be made by warming a pint of best rich whole milk to about 37° C. (98.6° F.), adding a teaspoonful of liquid rennet, essence of pepsin, or a junket tablet. When curdling has taken place the mixture is vigorously stirred until the curd collects into a lump. The whey is strained through sterilized cheese-cloth or a wire strainer, and put on ice until needed. Whey made as above, from good, rich, whole milk, will have approximately the following percentage composition:

Casein.	Soluble. Proteids.	Fat.	Sugar.	Salts.	Water.
0.03	0.85	1.0	4.9	0.70	93.0

About two ounces of this whey warmed to blood-heat may be given during the first twenty-four hours to an infant of average size. Four ounces may be given the second day, and from eight to ten the third. The fourth or fifth day a little cream may be added to the whey, and a little sugar if desired.

A substitute food for continued use should fulfil the following requirements: (1) It should correspond in composition, digestibility, temperature, reaction, and quantity, as nearly as possible, to normal human milk. (2) Its preparation should be as simple and uncomplicated as possible. (3) It should not be expensive, and should be easily obtainable. The basis of an infant food must be milk, and in this country the only easily obtainable animal milk is that of the cow. Great care

is necessary in selecting the milk. It should be the mixed milk of a herd, and not that from a single cow, since the former is more nearly of constant quality. It should be as fresh as possible, and clean. Milk from grass-fed cows is to be preferred. For use in large cities, milk that has been bottled at the dairy, well iced, and subjected to the least possible amount of handling in shipping, is best.

Difference between Human and Cow's Milk. To properly understand the modification of cow's milk for infant feeding, it is obviously necessary to know the differences in composition and properties between it and human milk. Some of the important differences are shown in the following table:

COMPOSITION OF HUMAN AND COW'S MILK.

	Human Milk.			Cow's Milk.		
	Average of 173 analyses (König).			Average of 470 analyses (König).		
	Minimum.	Maximum.	Mean.	Mean.	Minimum.	Maximum.
Specific gravity	1020	10364	10298	10314	10246	10368
Water	83.88	91.40	87.58	85.13	80.32	90.22
Total solids	8.60	16.12	12.42	12.87	9.78	19.78
Casein	0.20	1.85	0.80	2.81	1.91	4.65
Albumin	0.28	2.48	1.21	0.60	0.23	1.61
Fat	1.27	6.20	3.74	3.79	1.48	9.88
Sugar	1.78	8.76	6.37	3.80	3.23	5.67
Citric Acid	1.04	0.10	0.05	0.10	0.10	0.15
Unknown Extractives	0.29	0.97	0.69	0.20	0.18	0.30
Salts	0.13	1.87	0.30	0.77	0.50	1.45

It will be seen that the range of variation in composition of both milks is considerable. These variations include abnormal or pathological milks, and will largely disappear when the mixed milk of several individuals is considered. Mixed cow's milk of good quality will not vary much in composition from that given in the column marked "average." When the averages of the two milks are compared, we observe that human milk contains one-third more sugar, twice as much albumin, less than one-third as much casein (precipitable by rennet), and a little less than one-half as much ash as cow's milk. The most marked quantitative differences are in sugar and the proteids. The proteids are chiefly casein and albumin, although a small quantity of a peculiar globulin is also present. The casein, or that part of the proteids which is precipitated in the human stomach by rennin or by the gastric acid, is three or more times as great in cow's as in human milk. By reason of this, as well as differences in composition of the two kinds of casein, the curd of cow's milk is larger in amount, tougher in consistence, and less easily digested than that of human milk. Indeed, the casein of human milk is only partially precipitable by acids, and in some cases imperfectly by rennin. The amount of soluble albumin in human milk is twice that of cow's milk. More than one-half the proteids of human milk remain in solution until they leave the stomach, while four-fifths of the proteids of cow's milk are precipitated in a solid curd soon after it enters the stomach. The relation between the quantity of lactalbumin and casein is a matter of great importance in determining the behavior of milk when coagulated. In the presence of a considerable amount of soluble albumin, the casein coagulates in fine flocculi, while without it, these are much larger and show a tendency to collect in masses. The normal ratio between albumin and casein in the human milk during the

TABLE II.—HUMAN AND COW'S MILK COMPARED.

	Human Milk.	Cow's Milk.
Appearance	Bluish, translucent, odorless, sweetish.	White, opaque, odor, and slightly sweet taste.
Specific gravity	1026 to 1036.	1030 to 1036.
Reaction	Amphoteric or alkaline. Remains alkaline a long time.	Amphoteric or acid. Rapidly becomes acid in the air.
Behavior on boiling	Does not coagulate, but forms a very slight film of albuminoid matter.	Does not coagulate, but forms a thicker film consisting of casein and lime salts, which, when removed, is rapidly renewed.
Coagulation	Coagulates at ordinary temperature after many hours.	Coagulates much earlier than human milk.
Coagulation with rennet	Coagulates incompletely in fine flocculi, which never precipitate in distinctly visible masses.	Coagulates at body temperature, and separates into distinct masses, leaving a supernatant yellowish liquid.
Fat	Yellowish-white, similar to cow's butter; specific gravity at 15° C. = 0.966; melts at 34° C. Composition: butyrin, caproin, caprin, myristin, palmitin, stearin, and olein.	Yellowish-white mass, specific gravity at 15° C.= 0.996; melts at 35.8° C. Composition: butyrin, caproin, caprin, palmitin, stearin, olein, myristin, caprilin, laurin, arachin, leucitin, cholesterin, and yellow coloring matter.
Relation of fatty acids	Relatively poor in volatile acids; of the non-volatile acid sone-half is oleic; of the remainder, myristic and palmitic predominate.	The volatile acids relatively large. Of the non-volatile acids, 3 to 4 per cent. is oleic; the remainder is a mixture of principally palmitic and stearic.
Casein . . .	Precipitated with difficulty by acids and salts; the precipitate dissolves easily in excess of acids. In peptic digestion it leaves little residue. Contains little $Ca_3(PO_4)_2$.	Easily precipitated by acids and salts; precipitate not easily dissolved by excess of acids. In pepsin digestion it leaves considerable residue. Contains more $Ca_3(PO_4)_2$ than human milk.
Composition of proteids	Albumin 1.1 per cent., casein 0.55 per cent., globulin 0.1 per cent., albumin to casein 2 to 1. 100 c.c. contain 0.175 gramme lecithin and 0.120 gramme nuclein. Nearly all the phosphorous is in organic combination.	Albumin 0.60 per cent., casein 3 per cent., globulin trace, albumin to casein 1 to 5 to 1 to 10. 100 c.c. contain 0.110 lecithin and 0.55 gramme nuclein. Less than half the phosphorus in organic combination.
Extractives .	More than in cow's milk.	Less than in human milk.
Mineral matters in ash	K_2O Na_2O CaO MgO Fe_2O_3 P_2O_5 Cl 0.780 0.232 0.328. 0.064 0.004 0.473 0.438 Contains less ash than cow's milk.	K_2O Na_2O CaO MgO Fe_2O_3 P_2O_5 Cl 1.72 0.510 1.98 0.200 0.003 0.820 0.980. Contains more ash, especially CaO and PO. Contains 6 times as much Ca_2O_5 as human milk.
Bacteria . . .	Generally sterile. Exceptionally a few staphylococci albus and s. aureus.	Contains all milk bacteria, and occasionally typhoid, diphtheria, tubercular, and other bacteria.
Citric Acid . .	About 0.05.	About 0.10 to 0.15.
Enzymes . . .	Amylase, lypase and fibrin ferment.	Amylase, oxidase and a proteolytic ferment.
Umikoff's reaction	Positive.	Negative.

second month of lactation is nearly 2 to 1 while in cow's milk it is nearly 1 to 5 (Camerer.) Monti has called attention to the fact that when the proportion of albumin to casein is diminished, the infant suffers with digestive disturbance. The percentage of total proteids in human milk is greater during the first weeks of lactation than afterward, and the ratio of albumin to casein is greater. These differences in the composition of the proteids of human and cow's milk are too

often lost sight of in attempts to adjust the latter to suit the digestion of the infant. These differences in composition and behavior of the proteids of the two milks explain why the infant experiences so much difficulty in digesting cow's milk. But these are not the only differences in the proteids. Human milk contains, according to Siegfried[1] and Stoklassa,[2] about 0.12 per cent. of nuclein, and about the same percentage of lecithin, including nearly all the phosphorus of the milk in this organic combination. Cow's milk contains less than half as much nuclein and lecithin. But one-half of the phosphorus of cow's milk is organic or tissue-building phosphorus. From what we know of the nutritive value of nuclein and lecithin, it would seem that cow's milk, even when fed in the undiluted state, cannot nourish an infant as well as human milk. Boiling or sterilizing destroys much of both the nuclein and lecithin of cow's milk, and greatly reduces the nutritive value of the milk. This will be referred to later in considering sterilized milk.

Modified Cow's Milk. By this term is meant cow's milk that has been changed in composition so as to render it easy of digestion by the infant. No known method can make a perfect substitute for human milk. The supposed average composition and behavior of human milk is taken as the standard for the preparation of mixtures for infant feeding.

The first requisite is a pure, clean, fresh cow's milk. This cannot always be obtained, in cities, but in most large cities pure, clean milk is sold under the certificate of a commission of physicians, under the name of "certified milk." When obtainable, this is the safest and best milk for infant feeding.

It usually contains at least four per cent. of butter fat and a low bacterial content, which latter is taken as a test of freshness, cleanliness, careful production and care in handling.

When certified milk, or a milk whose history is known, cannot be obtained, the difficulties of substitute feeding are greatly increased, because of the liability of market milk to be infected with harmful bacteria.

Because of this danger, and the difficulty of keeping ordinary milk sweet in hot weather, sterilized milk, Pasteurized milk and condensed milk have been largely used for infant feeding.

Sterilized Milk. In large cities, and whenever cow's milk cannot be obtained "fresh from the cow" twice a day, it is necessary to adopt some means of checking the fermentative changes in it. Experiments show that cow's milk when first drawn from the udder, under the best conditions, contains from forty to several hundred bacteria in each cubic centimeter. After six hours, at ordinary temperatures, it contains from 5000 to 10,000 in each cubic centimeter. These bacteria multiply very rapidly, producing detrimental changes in the milk, unless their growth is checked by a very low temperature, by the use of antiseptics, or by the application of heat. The well-known process of sterilization consists in heating the milk to 100° C. (212° F.), for a sufficient time to destroy the bacteria, and most of the spores of bacteria, without

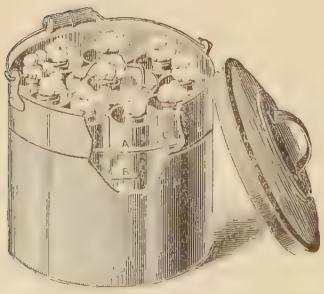
[1] Zeitschr. f. phys. Chem., 1896, p. 576. [2] Ibid., 1897, p. 343.

producing too great changes in the taste of the milk. In practice, the time of heating varies from fifteen to forty-five minutes. Complete sterilization can be accomplished only by heating the milk to 110° C. for fifteen minutes.

Sterilization at 100° C. produces the following changes in milk, which are undesirable:

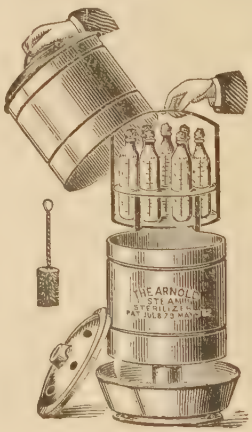
1. A part of the sugar is decomposed or caramelized, giving the milk a disagreeable taste; the sugar loses its diuretic and laxative properties.
2. The fat is melted, the emulsion largely destroyed, and the fat is rendered less digestible.
3. The casein is changed, so as to be less easily affected by rennet, and when coagulated, it forms tough indigestible curds, which may be found in the stools.
4. The albumin and globulin are coagulated, and made capable of precipitation with the acids of the gastric juice, thus increasing the size and toughness of the curd formed in the stomach, and making it less easily digestible.
5. The nuclein and lecithin of the milk are largely destroyed, and the peculiar nutritive function of these bodies is lost. Most of the organic phosphorus is converted into nonassimilable calcium phosphates.
6. The potassium citrate is converted into insoluble calcium citrate, which is thus lost.
7. The salts are rendered more insoluble; especially is this true of the phosphates.

FIG. 225.



Freeman's Pasteurizer.

FIG. 226.



Arnold's milk sterilizer.

Children fed exclusively upon sterilized milk fail to thrive as well as when fed upon unsterilized milk, and show a tendency to develop rachitis.

The advantages of sterilized milk are:

1. The destruction of disease germs.
2. The prevention, to a great extent, of the accidents due to sour or infected milk.
3. The increased keeping quality of the milk, without ice, and on long journeys.

Pasteurization or Partial Sterilization at a temperature not exceeding 70° C., 158° F., has now practically superseded complete sterilization. Most proteids coagulate at 73° C. to 75° C. (163.4° F. to 167° F.), while lactalbumin coagulates at 77° C. (170.6° F.). The temperature should not, therefore, be allowed to reach 77° C. (170.6° F.). This temperature is above the thermal death-point of the lactic-acid ferment and of most pathogenic organisms. The bacillus tuberculosis, the bacillus typhosus, bacillus diphtheriæ, and bacterium lactis are all killed by fifteen minutes' exposure to a temperature of 65° C. (149° F.).

The simplest and most practical Pasteurizer in the market is that devised by Dr. Freeman, of New York, (Fig. 225). It consists of a tin pail provided with a groove to indicate the amount of water to be added. The water is heated to boiling on an ordinary cooking-stove. The milk, contained in bottles plugged with cotton, is placed in the zinc cylinders of the rack, the space about them filled with cold water, the rack lowered into the boiling water, the cover put on, and the pail removed from the stove. The latent heat of the water is just sufficient to heat the milk to about 68° C. (154.4° F.), when all the bottles are filled. After half an hour the cover is removed, the rack containing the bottles is raised partly out of the water, and cold water run into the pail until the milk is cold. This process will greatly increase the keeping quality of the milk without perceptibly changing its chemical properties or taste. Arnold's milk sterilizer (Fig. 226), may be used for pasteurizing, but it is not so easy to secure a fixed and certain regulation of the temperature. The temperature varies with the rapidity of the boiling of the water.

Condensed Milk. Condensed milk has been a popular food for infants ever since its introduction. The canned milk, which contains cane-sugar added as a preservative, is most commonly used. The makers claim that such milk is condensed to one-fourth the original volume, but analysis shows that it is usually condensed to one-third—*i. e.*, when diluted with two volumes of water it will give a liquid containing the same percentages of milk-solids as the original milk, together with about 12 to 13 per cent. of cane-sugar. Meigs has shown that when one part of the best commercial sweetened condensed milk is diluted with nine parts of water, the mixture somewhat closely corresponds in composition with human milk, with the exception that it is deficient in fat and contains cane-sugar for a part of the lactose. A mixture of one part of condensed milk, one part of Pasteurized cream (containing 12 per cent. of fat), and eight of water, more closely resembles human milk in composition. While many infants will apparently thrive on this mixture, it has all the disadvantages of sterilized milk, and infants fed upon it sooner or later almost invariably show signs of rachitis.

It should be remembered that sterilization and pasteurization are sanitary measures used to protect infants from dirty or contaminated milk. When a clean, pure fresh milk is to be had they should not be employed, as the infant will thrive better on the raw milk.

Methods Used in Modifying Milk. Many methods of modifying cow's milk have been proposed, but it must be understood that no method known can produce a perfect substitute for mother's milk. The aim should be to prepare a food which the infant will digest easily and comfortably, and upon which it will thrive. Usually this will be found to

be a close imitation of human milk in composition and behavior during digestion. The methods usually employed are the following:

1. Simple dilution with water.
2. Dilution with cereal gruels, such as barley, oatmeal, corn-starch, wheat flour; or with gelatin, gum arabic, egg albumin, or sugar water.
3. Mixtures of milk, cream, sugar, and water.
4. Removing a part of the casein by means of rennin and adding sugar.
5. Partial peptonizing of the proteids, and dilution with water.

Dilution with Water to the extent required by the excess of proteids in cow's milk, reduces the fat and sugar below the proportion necessary for the nutrition of the infant, and such modification alone is seldom successful with very young infants.

When the infant has reached the age of six months, simple dilution with an equal volume of boiled water may be tried.

Dilution With Cereal Gruels. This is a very old method of modifying milk. Barley water, oatmeal water and other thin cereal gruels have been used for years as diluents of milk or cream for infant feeding.

These are usually made of the strength of one heaping tablespoonful of cereal to a pint of water, and should be kept at or near the boiling point for at least an hour, to render the starch soluble and to convert some of it into dextrin. This gruel will contain about from 2.0 to 2.3 per cent. of carbohydrate and from 0.2 to 0.3 per cent. of vegetable proteid.

As dextrin is more easily digested by the infant than starch, a dextrinized flour, like imperial granum, may be used for making the gruel.

Instead of this, some have used one of the commercial thick extracts of malt, in the proportion of one to two tablespoonfuls to the pint of water, as the diluent. Others prefer to make the gruel as above mentioned, of wheat, barley, rice or oat flour and dextrinize this with freshly prepared extract of malt.

Whichever of these solutions be selected, they should be regarded as aiming at producing a soft, easily distintegrated curd instead of the more tenacious curd produced by the coagulation of undiluted cow's milk.

The chief disadvantages that have been urged against the use of these gruels, made from the cereals, is that the infant, prior to the fourth month, has little power of digesting starch, and that the vegetable proteid is not as easily digested as lactalbumin.

Recent investigations have shown, however, that the pancreatic secretion is capable of development, in its amylolytical power, under the use of boiled starch or dextrin, so that many infants soon develop the ability to digest it.

The first of these objections is met by the use of dextrinized gruels.

Chapin, of New York, prepares an infant food by home modification of cow's milk, by dipping the cream from a bottle of market milk with a special dipper holding one ounce (See Fig. 227), and diluting this with a dextrinized gruel. By removing in this way nine dipperfuls from the top of a quart bottle, there are obtained nine ounces of a rich milk, containing approximately 12 per cent. of fat and 3.4 per cent. of total proteids. This is then diluted with dextrinized cereal gruel sufficient to make thirty-six ounces. The composition of this food will be

approximately: Fat, 3 per cent.; milk-proteids, 1 per cent.; sugar, 1.1 per cent.; of dextrin, cellulose, cereal proteids, and salts, an unknown amount. Milk-sugar is added to increase this constituent to about 6 per cent. To increase the amount of milk-proteids in the finished product, it is only necessary to dip off more dipperfuls of the top milk, and add less than three times as much gruel. To increase the fat without increasing the proteids, a less amount of cream is dipped out, say six ounces. This cream, if carefully dipped from the cream layer of an ordinary quart bottle of well-creamed milk, will contain about 20 per cent. of cream and about 3.3 per cent. of proteids. If to this cream four volumes of diluent are added, the mixture will contain about 0.7 per cent. of proteids and 4 per cent. of fat. The sugar will be reduced to about 0.9 per cent., and 5 per cent. of sugar must be added, or a little over 1.5 ounces to the quart of food.

FIG. 227.

1 oz. dipper for removing top milk.

In this method of modifying cow's milk the author believes that the casein is not only reduced to such a quantity that the infant can digest it, but that it is rendered more digestible by the fact that the coagula are rendered more flocculent and easily disintegrated by the presence of dextrin and the soluble proteids of the cereal. The soluble proteid is increased by the gruel, especially when oatmeal or barley is used, and thus the ratio between this and the casein is made more nearly like that of human milk, although the amount added is necessarily somewhat uncertain. This, however, is not a matter of supreme importance. The carbohydrate content of this food is increased by the addition of dextrin and maltose. When prepared by unskilled hands, the quantity of maltose must vary within wide limits.

Cream Mixtures—Percentage Feeding. A mixture of cream, milk, sugar water and lime water has been recommended by Biedert, Meigs, Rotch and others, and has been used with success for many years. This mixture first suggested by Biedert, was modified by Meigs, and further changed by Rotch. It is made as follows:

Cream (20 per cent. fat)	3 ounces.
Milk	2 "
Milk sugar	7 drachms.
Lime water	1 ounce.
Boiled water	10 ounces.

The analysis of this mixture will give about the following composition:

Water 88.42 Solids 11.58 Fat 4 Sugar 6.26 Proteids 1.11 Ash 0.21

The composition of the mixture will vary somewhat with the composition of the milk used.

When gravity cream is employed, or a cream whose content of fat is unknown, the composition must be uncertain. One great objection to this mixture is in the fact that commercial cream is now often weeks or months old before it is marketed and in a state of advanced decomposition.

When such cream is used it will produce vomiting or other disturbance in the baby. It is therefore unsafe to use this formula unless the cream be of known composition and freshness. Centrifugal cream,

when fresh, has the advantage that it is fairly uniform in composition, and is sold in two grades, of about 20 per cent. and 40 per cent. of fat. It has the disadvantage that the natural emulsion has been somewhat destroyed by the centrifugal process.

Percentage Feeding. By this term is meant the adjustment of the constituents of modified milk to known percentages. Much importance has been attached to the necessity of exact percentages of the various constituents in the feeding of infants, taking the supposed composition of the human milk as a guide. While such discussions have led to more intelligent and systematic methods, exactness is unnecessary and impracticable. Anything approaching exactness can be attained only in a well conducted laboratory.

Such *milk laboratories* have been established in many of the larger cities of this country for the purpose of preparing exact-percentage modified milk. Mixtures of any desired composition may be ordered from these laboratories, and the composition can be changed as desired.

These milk laboratories were organized through the efforts and under the supervision of Dr. T. M. Rotch of Boston, who adopts the following working basis for feeding infants during the first three months. It must be understood, however that these figures may require modification to suit individual cases.

Slight changes in the percentage of fat, proteids or sugar may be of great value in managing cases of difficult digestion or of malnutrition.

	I.	II.	III.	IV.	V.
Fat	2.00	2.50	3.00	3.50	4.00
Milk sugar	5.00	6.00	6.00	6.50	7.00
Albuminoids	0.75	1.00	1.00	1.50	1.50
Mineral matter	0.11	0.17	0.17	0.25	0.25
Total solids	7.86	9.67	10.17	11.75	12.65
Water	93.14	90.83	89.83	88.25	87.25

The following may be given as a sample prescription to be tried for a new-born infant after the second day:

Fat	2 per cent.
Sugar	5 "
Proteids	0.75 "
Lime-water	5 "
Number of feedings	10

Put up in ten bottles, each containing one and a half ounce. Pasteurize at 167° F. for fifteen minutes.

Should this mixture agree, the sugar and fat should be increased at the end of the first week by one-half per cent. The sugar may be increased to 6 per cent. at the end of the second week, unless the child has colic. It is not always easy to determine the cause of the disagreement, but a few trials with varying percentages of fat, proteids, and sugar will enable the practitioner to adapt the food to the needs of the individual case.

It will seldom be necessary to depart from the known variations in human milk, as given in the table on page 274.

Too large a percentage of sugar may cause greenish, acid stools and colic, and too low a percentage will usually lead to dry stools and failure of the proper increase in weight.

Too large a percentage of fat may give rise to vomiting, diarrhœa, and fatty masses in the stools. In some cases an excess of fat may cause

colic. A deficiency of fat frequently occasions constipation, with dry, hard stools. The fat should rarely be increased above 4 per cent., and it is seldom that more than 3.5 per cent. is necessary.

An excess of casein is the most frequent cause of digestive disturbance in bottle-fed infants. The casein should never be more than 1 per cent. to begin with, and in most cases less than this will be found to give the best results.

The most certain indication of too large an amount of casein is the presence of curds in the stools. It must be remembered that free fatty acids so closely resemble curds as to deceive the naked eye. In such cases the stools are strongly acid, and they irritate the nates and genitals, causing erythema. These lumps of fat or fatty acids are soluble in ether, while the casein lumps are insoluble in that reagent.

Sometimes the child is unable to digest even a very small amount of casein, unless it be accompanied with albumin, or gelatinized or dextrinized starch or some similar substance. The addition of one or two grains of potassium citrate to the ounce of food will sometimes greatly assist in the digestion of the casein.

We have already called attention to the importance of a proper relation between the percentages of albumin and casein. The addition of a small amount of egg-albumin to the food will sometimes assist in the digestion of the casein. If we attempt to correct the proteid indigestion by reducing the proportion of proteids, the child may suffer for want of nitrogenous food.

Whey Mixtures. Whey is prepared from milk by removing the casein. This may be done by coagulating the casein with acid and heat, as in heating butter-milk, or with rennet.

The difficulty which most infants have in digesting the casein of cow's milk may be overcome by reducing this constituent by dilution with water or other diluent, as already described, or it may be partially removed, leaving the other necessary constituents undiluted.

Various methods of manipulating mixtures of whey and milk have been proposed. Vigier divides a quart of milk into two equal portions. Let both stand for four hours in a cool place, skim the cream from one portion and add it to the other. To the skimmed portion add a teaspoonful of liquid rennet, warm to 35° to 40° C. (95° to 104° F.), let set for ten or fifteen minutes with frequent stirring, or until it forms a tough curd. Then heat to 68° C. (155° F.) to kill the rennet; strain and cool.

For infants under five months of age, mix equal volumes of this whey and the enriched portion; for infants over five months of age mix two parts of this enriched milk with one part of whey.

Monti uses a mixture of whey and milk in equal volumes, for the first three months, and a mixture of two volumes of milk and one of whey for infants over three months of age.

The above method of modifying milk presents certain advantages over the methods already described, in that it adds nothing to the milk, and removes nothing but the indigestible casein. It is simple in manipulation and may be conducted by any one of ordinary intelligence.

The Author's Method of Modifying Cow's Milk. This method consists in removing varying amounts of the top-milk from the bottle and diluting this with varying amounts of whey and adding sugar.

This process permits us to vary, at will, the three chief constituents of the milk to suit the digestive powers of almost any infant. For carrying out the process, three grades of top milk may be used.

The first, consisting of the upper one-fourth of a well creamed bottle of certified milk, (containing about four per cent. fat), containing approximately 14 per cent. of fat.

The second, consisting of the upper one-third of a bottle of milk, containing approximately 10 per cent. of fat.

The third, consisting of the upper half of a bottle of milk, containing about 7.5 to 8 per cent. of fat.

With these three grades of top milk and whey made from the skim milk, mixtures of a very considerable variety may be made.

FIG. 228.

Method of siphoning off the under milk.

The top-milk may be obtained either by siphoning off the milk with a glass siphon tube, as shown in Fig. 228, or the top may be dipped out with the Chapin dipper, holding exactly one ounce, and shown in Fig. 229.

FIG. 229.

Chapin dipper.

To use the siphon it is necessary to fill the tube with water, place the finger over the longer limb, pass the shorter limb through the cream layer to the bottom of the bottle and remove the finger, when the skim milk will run out leaving the cream layer undisturbed in the bottle.

The Preparation of Whey. When the whey is to be employed as the sole food for an infant, as during the first week of life, or in very feeble infants, or after serious gastro-intestinal troubles, it should be made from whole milk. When whole milk is used in making whey, and the curd is well beaten during its formation, much of the fat of the milk is left in the whey, and the fat content will usually vary between one and two per cent.

The whey employed in the following process is usually made from the skim milk siphoned from the bottle, or left in the bottle after removing the top milk with the Chapin dipper.

The percentage composition of this whey is approximately as follows:

Water	Fat	Sugar	Proteids	Inorganic salts
93	0.3 to .5	4.9	0.85	0.7

The skim milk is placed in the inner vessel of an household double boiler, a good essence of pepsin, or liquid rennet, added in proportion of a teaspoonful to a pint of the milk and slowly warmed to about blood-heat, and kept at that temperature until thoroughly curdled.

The temperature is then raised, with constant brisk stirring until the curd separates from the whey and collects into a tenacious mass. The temperature should be raised to between 150° F. and 155° F. which is high enough to destroy the activity of rennin. Milk preserved with formalin will fail to curdle as here described.

The whey is now strained through an ordinary wire coffee strainer, sweetened, cooled and mixed with the top-milk selected.

When it becomes necessary to feed an infant with artificial food from birth, it is best to begin it with whey made from whole milk, as above stated.

After a few days we may begin to add a small amount of top milk to the whey made from the bottom milk or skim milk.

The milk to be used for very young infants is the 14 per cent. top-milk, or the upper eight ounces.

This is diluted, at first, with five volumes of whey, when the fat will be reduced to about 2.4 per cent. *i.e.*, to one-sixth of the amount in the top-milk. The casein will also be reduced to one-sixth the original amount or to about 0.5 per cent. The sugar will remain the same as in the original cow's milk, and the albumin will be increased slightly by the whey proteid formed from the casein during the coagulation. As soon as it is deemed that the child will tolerate an increase of fats, a diminished dilution may be tried. A dilution of one of top-milk with four of whey will give approximately 2.9 per cent. of fat, 0.6 per cent. of casein and 0.79 per cent. of albumin. (See table, p. 304.)

A dilution of 1 : 3 will furnish a mixture containing about 3.6 per cent. of fat, 0.75 per cent. of casein and 0.77 per cent. of albumin.

For the later months the 10 per cent. top-milk may be used for making the mixtures, and at six to seven months the top half of the bottle may be used.

The amount of sugar in all these mixtures will be that of the cow's milk, which is usually fairly constant at 4.5 to 4.9 per cent.

It will usually be advisable to add about 1.5 per cent. of sugar or approximately 15 grms. (½ ounce) to the quart of food.

This amount will be supplied by adding a rounded over tablespoonful of lactose to the quart. As commercial milk sugar is sometimes contaminated with bacteria, which disturb the infant's digestion, only the best recrystallized milk sugar should be used. Because of the liability of certain commercial samples to be impure, some pediatrists prefer to use the purer granulated cane sugar. Practically, it is difficult to prove that pure cane sugar is not as successful as a sweetening agent as milk sugar.

Theoretically, one ought to admit that lactose is the natural sugar for infants, because it is the only one supplied by any mammal to its young.

The following table gives the approximate calculated composition of mixtures of top milk of the three grades with water (column *a*), whey (column *b*) and cereal gruels (column *c*).

For comparison, the composition of human milk and of condensed milk diluted with 4 parts of water are appended.

It must not be supposed that these figures represent the exact percentages always obtained in practice, but are only approximate. Exact percentages are not essential in artificial feeding. What is needed is a food that will agree with the baby and upon which it thrives and grows as a normal infant should. As above shown, mothers' milks vary greatly in composition, and without apparent disturbance in digestion or rate of increase in the weight of the infant.

Composition of Mixtures of Top-milk with Water (a), Whey (b), Barley Gruel (c) and (d).

Top-milk 14. per cent. Fat.	Dilu-ent	Fat			Caseinogen			Albumin			Barley Proteid	Lactose			Malt Sugar	Salts	
		a	*b*	*c*	*a*	*b*	*c*	*a*	*b*	*c*		*a*	*b*	*c*	*d*	*a*	*b*
1	3	3.6	3.7	3.6	0.75	0.75	0.75	0.12	0.77	0.30	0.18	1.22	4.9	1.22	1.52	0.15	0.70
1	4	2.9	2.9	2.9	0.56	0.60	0.56	0.10	0.79	0.30	0.20	0.81	4.9	0.98	1.6	0.10	0.70
1	5	2.4	2.4	2.4	0.48	0.50	0.48	0.08	0.81	0.28	0.20	0.82	4.9	0.81	1.8	0.10	0.70
10 per cent. top milk.																	
1	2	3.33	3.43	3.33	1.0	1.0	1.0	0.16	0.75	0.32	0.16	1.96	4.9	1.96	1.5	0.22	0.70
1	3	2.62	2.62	2.62	0.75	0.75	0.75	1.12	0.77	0.30	0.18	1.22	4.9	1.22	1.5	0.17	0.70
1	4	2.0	2.1	2.0	0.60	0.60	0.60	0.10	0.79	0.29	0.19	0.98	4.9	0.98	1.6	0.14	0.70
8 per cent. top milk.																	
1	1	3.9	4.0	3.9	1.5	1.5	1.5	0.25	0.68	0.37	0.12	2.45	4.9	2.45	1.1	0.25	0.70
1	2	2.6	2.6	2.6	1.0	1.0	1.0	0.16	0.75	0.32	0.16	1.63	4.9	1.63	1.5	0.23	0.70
1	3	2.0	2.1	2.0	0.75	0.75	0.75	0.12	0.77	0.30	0.18	1.22	4.9	1.22	1.52	0.18	0.70
Human milk.		3.		7.	0.	0.65		1.	0.			6.	5.		0.	.2	
Condensed milk.															cane sugar		
1	4	1.94			1.58			0.27				2.48			7.76	.38	

A heaping teaspoonful of lactose per quart of food adds 1.5 per cent. The white of one egg to the quart adds 0.3 per cent. of albumin.

The *Deming Milk Modifier* is designed to facilitate the construction of formulæ to contain any desired percentage of fat and proteid. It consists of a sixteen-ounce graduate (Fig. 230) which, besides the graduations in ounces, bears on the reverse side a table of five columns, a reproduction of which is given below:

Table of Graduations on the Percentage Milk Modifier.

Proteids. Top line.	Fat.			
16 oz.	Use 4 per cent. milk or whole milk.	Use 7 per cent. milk or the top 16 oz. from one quart.	Use 10 per cent. milk or the top 11 oz. from one quart.	Use 12 percent. milk or the top 9 oz. from one quart.
14 " — 2.4 per cent.	3.0 per cent.	5.2 per cent.	7.5 per cent.	9.0 per cent.
— 2.2 "	2.7 "	4.8 "	6.8 "	8.2 "
10 " — 2.0 "	2.5 "	4.4 "	6.2 "	7.5 "
— 1.8 "	2.2 "	3.9 "	5.6 "	6.7 "
8 " — 1.6 "	2.0 "	3.5 "	5.0 "	6.0 "
— 1.4 "	1.7 "	3.0 "	4.3 "	5.2 "
6 " — 1.2 "	1.5 "	2.6 "	3.7 "	4.5 "
— 1.0 "	1.2 "	2.2 "	3.1 "	3.7 "
4 " — .80 "	1.0 "	1.7 "	2.5 "	3.0 "
— .60 "	.75 "	1.3 "	1.8 "	2.2 "
2 " — .40 "	.50 "	.88 "	1.3 "	1.5 "
1 " — .20 "	.25 "	.44 "	.62 "	.75 "

In using the apparatus four grades of milk are employed. These are: (1) Whole milk of about 4 per cent. of fat; (2) 7 per cent. top-milk; (3) 10 per cent. top-milk; (4) 12 per cent. top-milk. To use the modifier, find the desired per cent. of proteids, in the first column under the

word proteids, then find the desired per cent. of fat in one of the columns on the same line to the right. At the top of the column where this per cent. of fat is found, read off the number of ounces of top-milk to be taken from the bottle of milk. Fill the graduate with this milk to the figures in the first column representing the desired percentage of proteids, and then fill to the top line or sixteen ounces with the diluent. This may be water, whey, or cereal gruel.

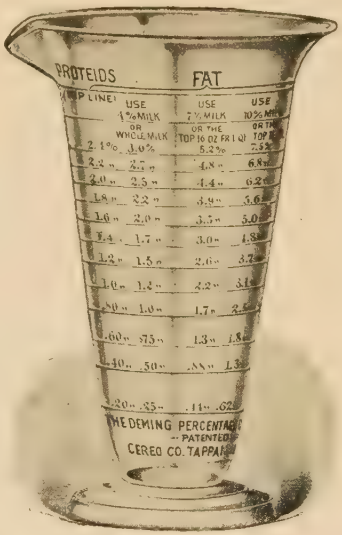
The percentage of sugar in the mixture will be approximately one and a half times that of the proteids.

The per cent. of sugar to be added will be found by deducting this from the desired percentage. Thus, if the proteids are 2 per cent., the sugar present will be 3 per cent. If 6 per cent. of sugar is desired, the sugar to be added will be 3 per cent. or a level tablespoonful of granulated sugar.

1	level	tablespoonful	of	granulated sugar	adds	3 p.ct.
2	"	"	"	"	"	6 "
1	heaping	"	"	milk	"	3 "
2	"	"	"	"	"	6 "

When whey is used as the diluent, the mixture will always contain about 4.9 per cent. of sugar, and a little over 1 per cent. of sugar is to be added, or two level teaspoonfuls.

FIG. 230.


PROTEIDS
FAT
TOP LINE
USE 4% MILK OR WHOLE MILK
USE 7% MILK OR THE TOP 16 OZ FROM
USE 10% MILK OR THE TOP
2.1% 3.0% 5.2% 7.5%
3.2 " 4.5 " 4.8 " 6.8 "
3.0 " 2.5 " 4.4 " 6.2 "
1.8 " 2.2 " 3.9 " 5.6 "
1.6 " 2.0 " 3.5 " 5.0 "
1.4 " 1.7 " 3.0 " 4.3 "
1.2 " 1.5 " 2.6 " 3.7 "
1.0 " 1.2 " 2.2 " 3.1 "
.80 " 1.0 " 1.7 " 2.5 "
.60 " .75 " 1.3 " 1.8 "
.40 " .50 " .88 " 1.3 "
.20 " .25 " .44 " .62 "
THE DEMING PERCENTAGE
PATENTED
CEREO CO. TAPPAN

Graduate glass.

When lime water is to be added, this may be done before the diluent is added, when it becomes a part of the diluent.

With this modifier a great variety of formulæ may be constructed with a minimum of skill and troublesome calculations.

When a given food disagrees with an infant it will probably be because of too much fat, casein or sugar. These constituents should be reduced, one at a time, until the cause of the trouble is found by experiment. It is then in order to see if the amount of nutriment given is sufficient to nourish the tissues properly. The weekly increase in weight is one of the best guides in determining this. It must be remembered, however, that the increase in weight is not the only criterion by which to measure the nutrition of an infant.

Infants fed on condensed milk often increase rapidly in weight but not in strength and development.

The normal increase in weight of an infant, after the first week, is about three ounces during the second week, four ounces the third, five ounces the fourth, and from six to eight ounces a week after that.

The feeding of sick babies will require a studied adjustment of the constituents of the food, often based upon repeated trials.

It may be laid down as a rule that a sickly baby will require a smaller percentage of fat and of casein than a well one of the same age. Weak mixtures should first be tried and then increased cautiously until the limit of tolerance is found.

It will be found at times that cereal gruels will agree better than whey, as the diluent, and in other cases the reverse. The addition of egg albumin to the food, in the proportion of the white of one fresh egg to the quart of food, will greatly assist the digestion of the casein. The egg must be fresh, lest the albumin may carry with it certain proteid-decomposing organisms which will do harm.

Peptonized Milk. In some cases *partial peptonization* may be necessary. This is accomplished by the following process: To a pint of the milk add 5 grains of extractum pancreatis and 15 grains of sodium bicarbonate. Warm the milk slowly to 104° F., and keep it at that temperature for ten minutes, then bring it nearly to the boiling point, to destroy the ferment. Instead of heating the milk to the higher temperature, it may be placed at once on ice. Peptonization may do good for a short time, but experience has shown that it is rarely well borne when long continued. It seems better to allow the digestive juices of the infant to accomplish the necessary changes in the food than to induce them outside of the body. If predigestion is practised at all, the process should not be carried beyond a partial digestion. This principle applies with equal force to all the predigested or partially digested foods of the market. Experience has shown that none of them is successful when used for a long time.

We may repeat here the statement that a process for preparing an exact substitute for mother's milk has not yet been devised.

The Nursing Bottle. One of the most important points in artificial feeding is scrupulous cleanliness of bottle and nipple. The long rubber tube connecting the bottle with the nipple must be discarded, and the bottle itself should be as round and tube-like as possible, to avoid angles in which sour milk may collect. The nipple should be a simple rubber cone with several very small openings at the end. These openings should require suction on the part of the infant to bring out the milk. If, upon inverting the bottle, milk streams through the nipple, the latter is unsuitable for use; the fluid runs too freely into the infant's stomach, and indigestion is likely to result. Both bottle and nipple must be scalded after using, and when not in use be kept in a solution of boric acid in water, or some other mild antiseptic solution.

Amount and Frequency of Feeding. The amount of fluid to be given at each meal and the interval between meals are matters of great importance. Irregular and hap-hazard feeding should not be countenanced. The physician should direct these matters as minutely as possible, giving detailed directions as to the preparation of the food, its preservation until needed, the kind, size, and form of bottle, and the amount and time of feeding.

In breast-feeding the quantity of fluid taken is determined by the quantity secreted, and usually regulates itself. Sometimes, however, the amount secreted is too great for the needs of the infant, and at others it is not enough. In bottle-feeding the tendency is to feed too much and too often. Overfeeding is much more harmful than underfeeding and is the most frequent cause of gastric dilation and gastro-intestinal disturbance in bottle-fed infants. The capacity of the stomach in infancy is subject to considerable variation, but, as a general rule, the gastric capacity of a child during the first month is one-hundredth the child's body-weight— *i. e.*, the greater the weight, the greater the gastric capacity.

Numerous measurements of the stomach capacity of infants, by different observers, as well as practical experience, have shown that the amount to be given at each feeding, the intervals between feedings, and the number of feedings in each day, are about those set forth in the following table. It must be understood, however, that these figures must be modified to suit individual cases:

Age.	Interval.	No. of feedings in 24 hrs.	Amount of each feeding.	Amount in 24 hours.
First week,	2 hours.	10	1 ounce	10 ounces.
1 to 6 weeks,	2 "	10	1½ to 2½ ounces.	15 to 24 ounces.
6 to 12 "	2½ "	8	2½ to 3½ "	20 to 28 "
3 to 6 months,	2½ to 3 hours.	6	4 to 5½ "	24 to 32 "
6 to 9 "	3 hours.	6	6 ounces.	36 ounces.
9 to 12 "	3 "	5	8 "	40 "

Gavage, or Forced Feeding. It becomes necessary at times to feed an infant, or even older children, by the forcible introduction of food into the stomach through a tube. Although this method of feeding has been practised for a long time in some European countries, its advantages have not until recently been fully appreciated in this country.

The method of practising gavage is very simple. The apparatus used is the same as that for stomach washing, and consists of a soft-rubber catheter, 12 to 16, American scale, or 24 French scale, a small funnel, two feet of rubber tubing, and a piece of glass tubing about three inches long to connect the rubber tubing to the catheter. The child is placed upon its back, the catheter is quickly introduced, the funnel raised so as to straighten the rubber connecting tube, and the food poured into the funnel. As soon as the food has almost all run down, the tube is pinched, to prevent the milk from trickling into the pharynx as the tube is removed, and it is then quickly withdrawn. The child should be kept absolutely quiet after feeding by this method. Should it offer much resistance to the introduction of the tube, the latter may be passed through the nose. In older children a mouth-gag is often necessary. If the food is regurgitated or vomited, the tube should be introduced a second time, and another feeding given. The intervals between feedings are generally longer when gavage is practised than under other circumstances. When this method is employed in feeding premature or feeble infants, the food should usually be predigested; if the mother's milk can be used this is unnecessary. It is well to wash the stomach before the first feeding, and at least once a day afterward while gavage is practised.

In connection with the incubator gavage has been found of great advantage in feeding premature infants; also after operations upon the throat and nose, and in other conditions in which the child may refuse food. The food is not often vomited when thus introduced, even when not retained in the usual method of feeding.

Signs of Normal Nutrition.—The best index of the nutrition of an infant is the rate of increase in weight. The study of the child's nutrition requires frequent weighing. The weight of the average infant at birth is, according to most authors, seven pounds and one ounce for girls, and seven pounds and eight ounces for boys. Others place the weight slightly lower, with less difference between the sexes.

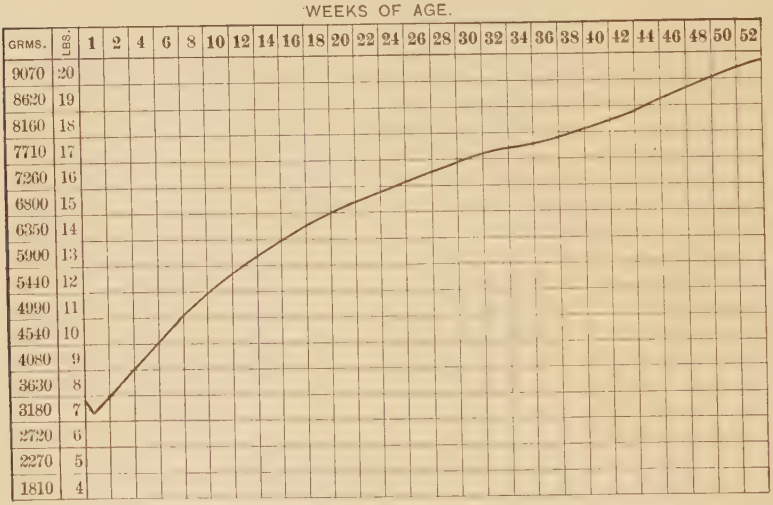
During the first three or four days after birth there is a loss in weight of six to eight ounces, which is regained by the middle of the second week. A loss of twelve ounces, or a failure to regain the birth-weight by the beginning of the third week, at the latest, calls for careful investigation.

After the second week the weight should increase regularly, the child doubling its birth-weight by the end of the fifth month. While the rate of increase differs very considerably, a child that is not gaining six ounces a week cannot be said to be thriving as it ought. The accompanying chart, from Holt, shows the rate of increase in weight of the average well-nourished infant during the first year. (Fig. 231.)

The Feces. The character and amount of the stools of an infant often give an important indication of the quantity of food taken and the degree of digestion. They also give valuable information as to the cause of loss of weight and the character of the digestive disorder.

The stools of the new-born infant are greenish-black in color, and are termed meconium. Meconium is composed of intestinal mucus, bile, vernix caseosa, epithelium cells, hair, fat, cholesterin crystals, and calcium and magnesium phosphates. It is free from bacteria immediately after birth. On the third to the fourth day the stools change to a lighter color, and by the fifth day are lemon-yellow.

FIG. 231.



Normally the stools at this time are from three to four in twenty-four hours, smooth, semi-solid in consistence, nearly homogeneous in appearance, and have a slightly acid, not unpleasant odor. They contain fat, free fatty acids, calcium lactate, and a small amount of casein. The reaction of the feces in usually acid, but is sometimes neutral or even alkaline. The cause of the acidity is the presence of fatty acids, lactic, and sometimes butyric acid. The degree of acidity varies considerably,

yet excess of lactic and butyric acids may be considered pathological. The yellow color is due to bilirubin.

In diseased conditions the stools often become green, which color is usually attributed to biliverdin, but there is some doubt upon this point. Opposed to this idea is the fact that the stools are often yellow when passed, but become green on exposure to the air, while biliverdin on oxidation yields bilirubin, which is yellow and not green. In some cases at least the green color appears to be the result of fermentative processes, or to be caused by the excessive production of lactic acid and the action of this upon the biliary coloring matters.

There will usually be found with the green-colored stools more or less undigested casein, pseudo-nuclein, and free fatty acids. These appear as white masses distributed through the feces. Fat may be distinguished from casein by its solubility in a mixture of alcohol and ether.

The normal stool of a nursing infant contains about 85 per cent. of water, 2 to 3 per cent. of fat, 0.2 per cent. of proteids, and 0.1 to 0.2 per cent. of cholesterin.

Excessively acid stools often irritate the nates and genitals, producing a troublesome erythema.

The stools of infants fed upon cow's milk do not differ materially from those of breast-fed infants, except that the amount is much larger, and they are more liable to contain caseous masses of large size, especially when sterilized milk is used.

Dry and pasty stools or an insufficient amount of fecal matter are often indications of a deficient supply of food. An excessive quantity of fecal matter is usually the result of indigestion or overfeeding.

Starch will often be found in the stools of infants fed upon cereal foods. Its presence may readily be shown by its blue color reaction with iodine. Mucus is contained in the stools in catarrhal enteritis or intestinal infection. The stools of infants are sometimes offensive in odor. Such stools indicate proteid decomposition. This decomposition is usually caused by the excessive growth of the *Bacillus proteus vulgaris*. This bacillus is antagonized by the lactic acid ferment, *Bacillus lactis aërogenes*, and by the lactic acid produced by it. A variety of other microorganisms are found in infants stools, such as the bacillus coli communis, micrococci, yeast-cells, etc. When excessive fermentations appear in any given case, the food should be changed for a few days. This will often be found to be the most efficient method of correcting a troublesome colic.

A careful inspection of the stools should be made in all cases in which there is reason to suspect any form of digestive disorder.

Care of Prematurely Born Infants.

Infants born before term require greater care than full-term children. Those born before the sixth month rarely if ever live. Of those born during the sixth month, a small proportion have sufficient vitality to survive, with proper care and attention. The prognosis will vary with the degree of prematurity and the development of the child. When but a few weeks are lacking to complete the full term, little extra care may be necessary. It is well, however, in such cases to omit the usual

bath, apply a liberal coating of sweet oil to the skin, after washing the face, and use extra precautions to keep the infant warm. If the circulation is good and the cry vigorous, the child may be dressed; otherwise, it should be wrapped in cotton, and all exposure and handling deferred until later. In some cases the infant may be so feeble as to require the application of artificial heat to maintain its vitality. This will be indicated by cold and cyanotic extremities, feeble cry, and inability to nurse.

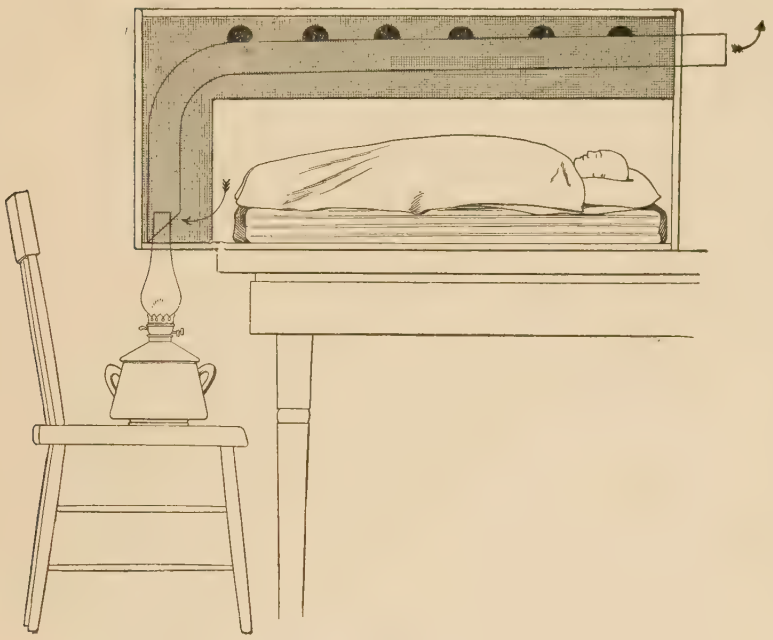
Incubators. Artificial heat may be applied by rolling the infant in blankets and placing a few bottles filled with water at a temperature of 105° F. in the blanket with it. A much better method is the use of an incubator. In private practice the physician may be called upon to improvise an incubator. It is a matter of the greatest importance that whatever measures are to be adopted to supply heat, they should be utilized as soon as possible. A simple, practical incubator may be constructed from a soap or candle box. Half-inch auger-holes are bored in the sides of the box about six inches above the bottom, and a pillow or other suitable bed is placed in the box, upon which the infant is laid, wrapped in cotton. The heat may be supplied by means of bottles filled with hot water and placed within the box.

The author has used an improvised incubator constructed as follows: There is required first a packing-box of suitable size, about 18 x 24 x 10 inches, and a piece of three-inch lead pipe, bent, as shown in Fig. 232. The longer arm of the pipe should be about the length of the box and the other a little shorter than its height. The end of the shorter arm is cut at an angle of sixty degrees. An opening is provided in one corner of the bottom of the box, larger than the pipe, and another in the opposite end near the top and at the corresponding side of the box. (Figs. 232 and 233.) The opening in the bottom of the box is covered with a plate of tin. The latter is provided with an opening large enough to receive the chimney of a kerosene lamp. The box is supported on two chairs, the pipe is put in place, with the long arm projecting an inch or two from the end of the incubator, and the short arm resting upon the tin plate covering the hole in the bottom. The pipe is protected by a piece of wire netting, folded over it and tacked to the side of the box. A series of auger-holes are bored near the top edge of the sides and at one end of the box, to admit air, and a glass plate is used to cover it. An ordinary kerosene lamp supplies the heat. The chimney of the lamp is passed through the hole in the tin plate, and well up into the pipe, so that no gases from the lamp can enter the box. The heat of the lamp creates a strong draught in the pipe, which not only carries off its own gases, but draws the air from the box through the open lower end of the pipe. The temperature of the air-chamber is regulated with a thermometer placed within by the side of the child. By raising or lowering the wick of the lamp the temperature can be raised or lowered, and can be adjusted to any desired degree. Moisture may be supplied to the air-chamber by hanging a wet sponge to the side of the box at any convenient place.

When once regulated it may safely be managed by any nurse, whether skilled or not. This is a matter of considerable importance in private practice.

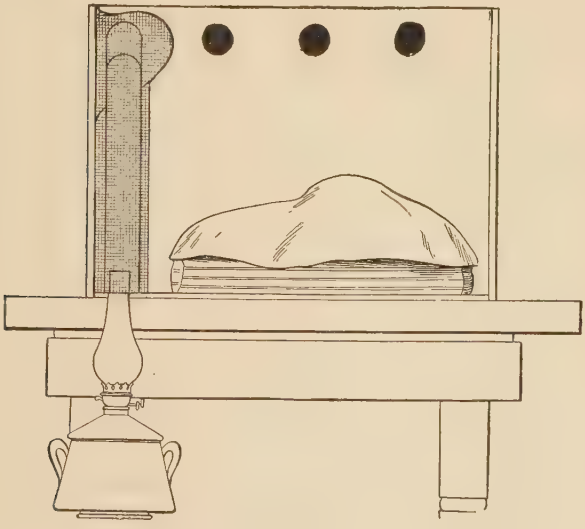
The temperature of the incubator for very feeble infants should be

FIG. 232.



Bartley's incubator. Longitudinal vertical section.

FIG. 233.

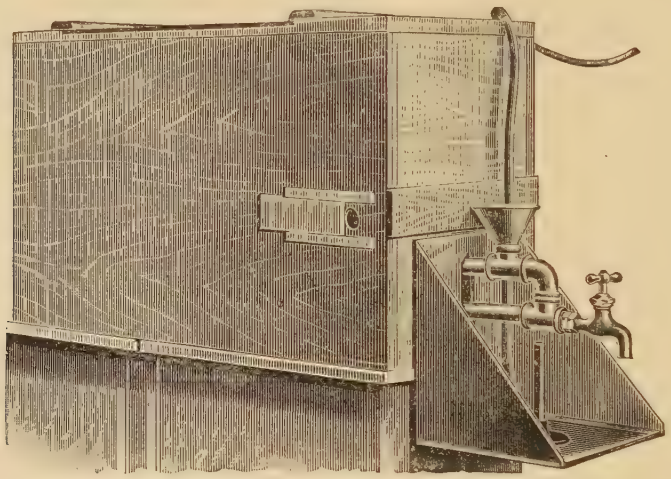


Bartley's incubator. Transverse vertical section.

kept at about 35° C. to 37° C., 95° to 98.6° F. For those a little stronger it may be from 30° C. to 35° C., 86° F. to 95° F.

An excellent incubator has been devised by Holt. (Fig. 234.) It is a modification of Tarnier's apparatus, and is less complicated and less expensive than many others that have been described. It consists of a double-walled box, thirty inches long, fifteen wide, and twenty high, with

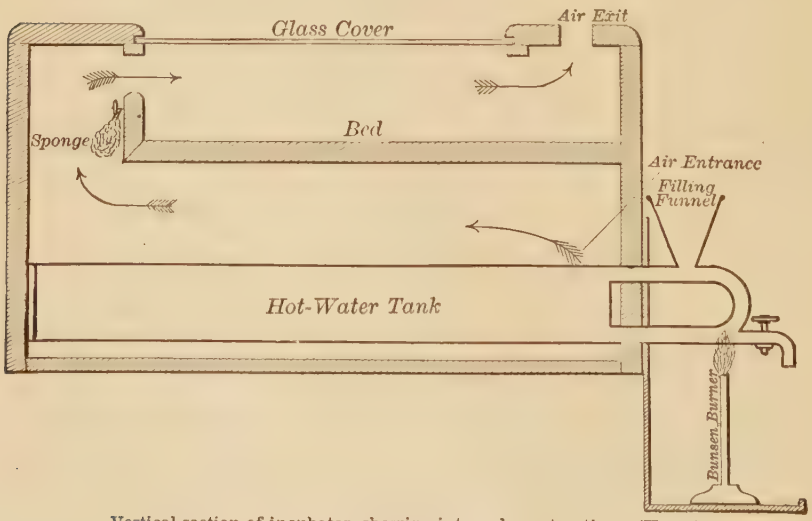
FIG. 234.



Incubator. (HOLT.)

a one-fourth inch air space between the inner and outer walls. A tank of warm water, four inches deep and covering the bottom of the box, supplies the heat to maintain the requisite temperature. A loop of

FIG. 235.



Vertical section of incubator, showing internal construction. (HOLT.)

brass pipe is connected with one end of the tank, and this is provided with a funnel for filling and a faucet for emptying the tank. The water

is heated by a Bunsen burner placed upon a shelf under the loop of pipe. The tank holds five or six gallons of water. Fresh air is admitted by four openings, three inches in diameter, two on each side of the box; a slide is so arranged as to regulate the admission of air at will. About six inches above the tank there is a shelf which serves as the support for the child's bed; a clear space of six inches is left at one end of the shelf. The air enters the openings above described, passes over the tank, then over a wet sponge and out at the top of the box. The internal construction is shown in Fig. 235. The top consists of a plate of glass, which may be pushed aside to admit of feeding the child without removing it from the incubator. The temperature is regulated by a thermometer. The infant lies upon a bed of cotton and enveloped in cotton. It is usually removed once daily for cleansing the chamber and renewing the cotton.

Holt says there is some difficulty in maintaining good ventilation with the room temperature at 75° F. or higher, but none at 65° to 68° F.

Rotch, of Boston, has devised a more complicated apparatus, but its expense is such that few will care to purchase it.

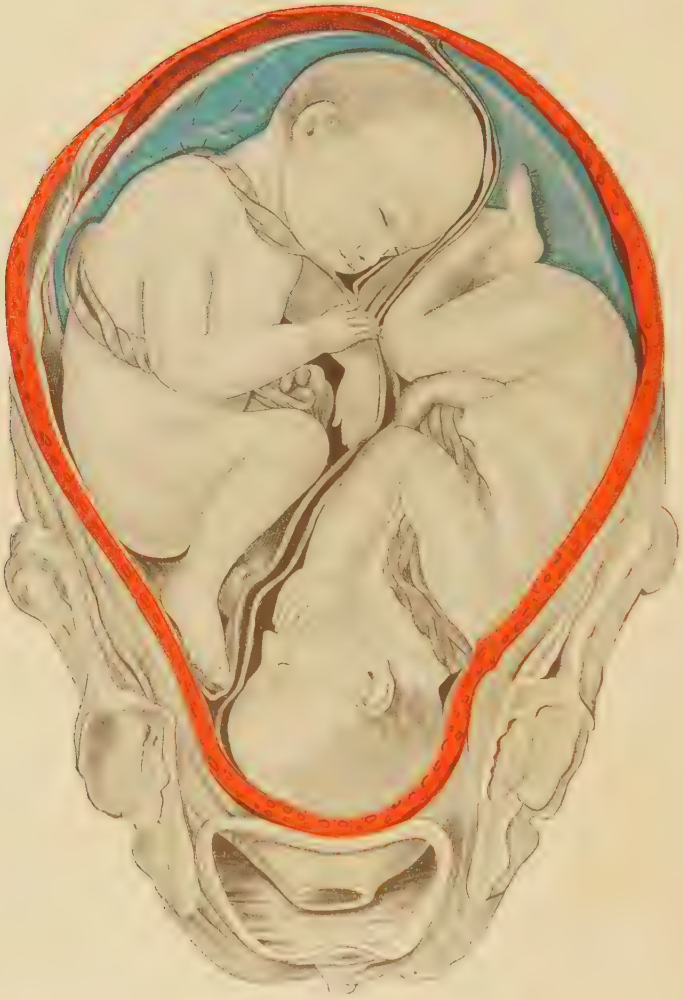
THE FEEDING of a premature infant will require special care. If left to itself it will not nurse from the mother, or from a bottle, in many cases. It may be necessary to feed it with a medicine dropper, giving the food frequently and in small quantity at a time. When breast milk is available, it should be pumped from the breast and given every hour or two. Or, for the first thirty-six hours after the birth, a 5 per cent. solution of milk-sugar, or freshly prepared whey, made from cow's milk by coagulating it with rennet and straining, as directed under Artificial Feeding, may be given. When breast milk is not available, whey may be exclusively given for the first week, and then it may be mixed with a little top milk, (10 per cent. fat) beginning with one-fifth rich milk, and gradually increasing this to one-third. When the child refuses to take sufficient food, as is frequently the case, gavage should be resorted to. A half-ounce of breast milk may be given every two hours to a seven months' child, and three-fourths of an ounce to an eight months' child.

The usual period the infant is to be kept in the incubator is from one to three months, but must be subject to the judgement of the physician in individual cases. It will depend on the circulation of the infant and upon its power to maintain its own body heat. When it is desired to discontinue the use of artificial heat, it is well to first gradually reduce the temperature of the incubator, day by day, to that of the room. It will usually be unsafe to dispense with the incubator until the child begins to gain weight and is able to nurse at the breasts or the bottle.

In many cases it will be advisable to keep the infant in the incubator until the period of full term has arrived. This, however, is not always necessary.

The habit of nursing may be cultivated by feeding through a nipple-shield.

PLATE XIX.



Uterus with Two-egg Twins. (After Smellie.)

PART V.

PATHOLOGY OF PREGNANCY.

CHAPTER XII.

MULTIPLE PREGNANCY.

By multiple pregnancy is meant the development of two or more embryos within the maternal organism at the same time. While, as a rule, this takes place within the uterine cavity (Plate XIX.), numerous cases are on record in which one embryo has found lodgement within the womb and another outside of it, combining uterine and extra-uterine gestation.[1]

The reason for the occurrence of multiple fœtation is not known, but speculation has given rise to many theories, the most plausible of which is that the condition is one of atavic manifestation. In its etiology the influence of heredity, especially on the mother's side, is well-established, but instances of a paternal bias are not wanting. Conditions, such as climate, environment, and the like, appear to have little effect in determining plural conception, yet in certain localities plural pregnancies occur with much greater frequency than in others. According to Kirschner, twin pregnancies occurred in Berlin in the proportion of 1 : 88 ; in Lubeck 1 : 118 ; in Dublin, 1 : 57 ; in Naples, 1 : 158.

Rumpe found that in twenty-nine cases of single-egg twins the mothers were under twenty-five years of age in 70 per cent., and in one hundred cases of two-egg twins the mothers were between twenty-six and thirty in 50 per cent. Strassmann states that the average age of the mothers of triplets is 31.4 years, 64.5 per cent. being over 30 years old.

Frequency. Twin conception is more frequent in women who have already borne children, and more so in old than in young primigravidæ. Of multiple pregnancies the commonest variety is *twins* ; *triplets* more rarely occur. According to Strassmann the frequency of triplets in a country is proportional to the occurrence of twins. *Quadruplets*, and even *quintuplets*, are met with exceptionally. Reported instances of a larger number of embryos developed simultaneously in the same woman have not, as a rule, been sufficiently authentic to merit credence. According to G. Veit, in 13,000,000 births, twins occurred once in 89, triplets once in 7910, and quadruplets once in 371,126 labors. For this country these figures may be accepted as approximately correct, though recent statistics from two of the largest eastern cities place the proportion of twins at one in every 120 labors, while Green found three cases of triplets among 5626 labors (one in 1875) in the records of the Boston Lying-in Hospital.

[1] In such instances both corpora lutea are found in the same ovary.

Mode of Origin. Twins may arise (1) from a single ovum, the germ dividing, (2) from two separate ova developing in the same Graafian follicle—rarely,[1] (3) from two ova extruded from different portions of the same ovary, or (4) from two ova each proceeding from a different ovary. Triplets arise from three distinct ova, or from one-egg twins and a single ovum, while quadruplets come from double twins or from twins and two single ova.

Of twins, those developing from two distinct ova are the most frequent, 85 per cent., while one-egg twins occur only in about 15 per cent.—(Bumm). The combined average weight of two-egg twins is greater than in the case of single-egg twins, while the difference in weight of the individual gemellus is more marked in the latter instance. This is probably due either to nutritive causes or to inherent weakness of a divided germ.[2]

Sex of Twins. Veit found that of 150,000 twin pregnancies in rather more than one-third both children were males, in less than one-third both were females, and in the remaining third both sexes occurred. The more recent statistics of Rumpe show that of 65 single-egg twins, both children were males in 36, and both females in 29, and of 101 two-egg twins, in 31 both were males, in 16 both were females, and in 54 each sex was represented. This indicates that in about 66 per cent. of twins both children are of the same sex, with the proportion of males largely in excess.

Arrangement of Membranes. The arrangement of the membranes in twin conceptions depends upon the origin of the embryos. The decidua vera is always single; the reflexa is single for one-egg twins, and double when two ova become attached at different portions of the uterine surface.[3] The chorion is, also, always single when two embryos develop from the same egg, and double when two ova are involved. The amnion, an individual product, is probably always primarily double. Where two embryos occupy a common amniotic sac, the median wall, which originally separated them, may undergo absorption, but careful search will generally reveal some vestige of its former presence.

The Placenta. As the embryonic portion of this organ is always of individual origin, it follows that in all cases of twin pregnancy the placenta is at first double. But the close proximity of the two structures in one-egg twins usually leads to fusion of their contiguous edges, with subsequent deep and superficial anastomoses of the bloodvessels; while in two-egg twins, although a widely distant implantation of the placentæ may result in their permanent separation, very frequently their borders will be found to have become united, with an easily recognizable intermediate zone lying between. Whenever two chorions are developed anastomosis of the placental vessels does not take place. *Placentæ succenturiatæ* (separate or accessory lobes) occur with frequency in twin pregnancies, as well as anomalies in the insertion of the placental end of the cord.

[1] While in the ovaries of the new-born child, and especially of the unripe fœtus, a Graafian follicle is sometimes seen to contain two, three, or even four ova (Pantellani), Waldeyer states that in the adult human ovary he has never found more than a single ovum in a follicle. Strassmann, Bumm and others, however, report instances of the presence of two and even three ova in the same follicle.

[2] In many instances of plural pregnancy malformations of the uterus and vagina (uterus bicornis, uterus bilocularis, double vagina) and polymastia have been found associated (Dunning and others)—in the mother.

[3] A single reflexa may exist where two ova are situated very near together.

The individual growth of twin embryos varies greatly, according to the proportion of blood supply furnished to each. Any interference with the circulation in the one—whether resulting from imperfect attachment, early partial separation from accidents to the placenta, anastomotic complications in joined placentas, inherent feebleness of the embryo, disorders of the membranes or the like—immediately acts to the advantage of the other; the latter, by its more rapid development and augmented strength, the expansion of its envelopes and increase of the surrounding liquor, soon acquires such supremacy over its fellow that this eventually perishes, and is either compressed and flattened against the uterine wall as a *fœtus papyraceus*, degenerates into a mole, or is prematurely cast off from the uterine cavity; the fortunate individual, on the other hand, continues to advance to the completion of gestation. It is estimated that the intra-uterine death of one embryo occurs with three times greater frequency in one-egg twins than in those developed from two separate ova, a circumstance readily accounted for by the fact that malformations and pathological conditions are much oftener met with in the former than in the latter.

Superfœtation. In rare instances it has happened that the atrophied body of the dead fœtus has been retained in utero for a considerable time after the expulsion of the living child at term. Occasionally, instead of perishing, the growth of the feebler embryo may be retarded only by the more rapid and vigorous advancement of the brother, and, after the delivery of the latter, may continue its intra-uterine existence for a period of weeks or even months until its development is completed. The fact of such a delivery following at an indefinite interval after the expulsion of the first child has led to belief in the possibility of superfœtation as opposed to superfecundation.

Superfecundation. By the latter term is understood the fertilization of more than one ovum, discharged at the *same* ovulation, by separate acts of insemination at short intervals, while superfœtation implies the impregnation of an ovum during such time as another ovum from a *previous* ovulation is in process of utero-gestation. While superfœtation is theoretically possible, it has not been proved.

Pathological Character. Possibly owing to the excessive distention of the uterus as much as to other causes—hydramnios being a frequent accompaniment—there exists a marked tendency in plural pregnancies to an early termination of gestation, and miscarriage and premature delivery are particularly liable to result in cases of one-egg twins, quadruplets, and quintuplets.

Both children in twin pregnancies may be expelled at the same labor, or at intervals ranging from eighteen to twenty-four hours, or even longer, as already mentioned. The offspring of plural pregnancies are often of feeble vitality, and one child is quite likely to succumb within a comparatively short time following delivery. Monstrosities are much more liable to be developed under these conditions, and the mothers are more prone to eclamptic attacks than when the pregnancy is simple.

Diagnosis of Multiple Pregnancy.

The existence of twin pregnancy may, as a rule, be determined with reasonable certainty by the following data: (*a*) Excessive size and tension of the abdomen are significant of twins. (*b*) Permanent uterine tension with very limited mobility should suggest multiple fœtation. Persistent tension is present in simple hydramnios, but here there is preternatural mobility of the fœtus. It also occurs in the concealed form of accidental hemorrhage, but the latter condition is distinguished by its shorter duration and by the signs of internal hemorrhage. (*c*) The abdominal tumor is usually broader than in single fœtation. Sometimes the abdomen presents a sulcus corresponding to the space between the two fœtuses; but this may arise from other causes. (*d*) Detection by abdominal palpation of two fœtal heads, or of two dorsal planes, of three or four fœtal poles, or of a multitude of small parts is usually possible. (*e*) Detection of one head in the excavation and one in the upper uterine segment makes the diagnosis of twins. (*f*) One head may be found in the excavation and one in an iliac fossa. (*g*) Distance from pelvic pole to fundal pole more than 30.5 cm., 12 inches, is evidence of twins. (*h*) The recognition, by auscultation, of two fœtal heart-sounds, not synchronous, and heard at different locations, is conclusive. It must not be forgotten, however, that one fœtus may be dead. Even when both are living the detection of two independent heart-sounds is frequently impossible. (*i*) Suprapubic œdema is almost invariably present in plural pregnancy. This, however, may occur in single pregnancy with hydramnios, since it arises from venous stasis in the abdominal wall due to pressure brought about by the greatly distended uterus.

Vaginal Signs. During pregnancy twin fœtation presents practically no characteristic signs obtainable by the vaginal examination. In course of the labor one or more of the following conditions may be detected. (*a*) Rapidly successive presentation of a head and a breech. (*b*) Four extremities presenting. (*c*) Two amniotic bags offering at the cervix.

The diagnosis of triplets is sometimes possible after the pregnancy has reached the later months. In quadruple pregnancy the existence of multiple fœtation should be capable of recognition, but the number of children can scarcely be determined before birth.

Management of the Labor. The usual risks of labor for both mother and child are somewhat increased in twin births. The labor is frequently longer and is more likely to be complicated than in single fœtation. Owing to overdistention, the uterus may retract less promptly in the third stage, and the danger of post-partum hemorrhage is greater. The viability of the child is less than in normal gestation. In nearly 25 per cent. of cases the labor is premature. These facts must be borne in mind in the management of the labor and the after-care of the children.

According to the statistics of Kleinwächter and of Speigelberg, in 50 per cent. or more of twin births both fœtuses present by the vertex. Breech and transverse presentations are more common than in ordinary labors.

When the first child is larger than the second, the second birth, as a rule, is rapid. The delivery of the second fœtus is rarely delayed more than a few hours. The cord of the first child should be ligated on the maternal as well as the fœtal side, owing to the possibility of communication between the placental circulations. The membranes of the second fœtus may be ruptured as soon as labor pains are resumed after expulsion of the first.

Interference in either delivery must be governed by the same rules as in single births.

Both placentas are usually expelled together after the birth of the second child. Very rarely, when the placentas are entirely distinct, the first one may come away before the expulsion of the second fœtus.

Special care will usually be required by manipulation and the use of ergot to secure full retraction of the uterus.

In triple births the management is, in general, the same as in twins.

CHAPTER XIII.

ABNORMALITIES AND DISEASES OF THE DECIDUA AND FŒTAL APPENDAGES.

DISEASES OF THE DECIDUA.

Decidual Inflammation. As the decidua is merely the hypertrophied and modified endometrium, the same changes occur in it as in the non-pregnant organ. With the exception of the acute processes, they are more often the result of nutritional disturbances than inflammatory change. They are, undoubtedly, more frequent than is generally appreciated, being the cause of many interruptions of pregnancy that are usually ascribed to traumatism or to unknown causes.

Etiology. The causes are practically the same as those for endometritis. The changes most commonly represent the continuation of some nutritional disturbance that has existed prior to pregnancy in such a mild form as not to prevent the occurrence of impregnation, although frequently interfering with its continuation to full term. Syphilis is probably less frequently a cause than the older writers would lead one to infer. Tuberculosis, however, seems to be a factor of increasing importance. In the acute cases, traumatism and infection from unskilled attempts to induce abortion may be causes. Gonorrhœa is, undoubtedly, a frequent and important one, that deserves a wider recognition than has hitherto been given to it. All of the acute infectious diseases, either through the toxicity of the blood or through direct bacterial invasion of the uterine structures, must be recognized as occasional factors.

Acute Inflammation of the Decidua is generally regarded as rare, although with the better appreciation of gonorrhœa as a cause, it will probably be found to be more common. Its pathological features are those of an acute exudative inflammation. An interruption of the pregnancy usually results.

Chronic Changes in the Decidua are the most common manifestations of the disease. They may involve all of the parts of the decidua, or they may be localized in the decidua vera or in the decidua basalis, or less frequently and less extensively, as shown by Seitz, in the decidua capsularis before it has joined with the decidua vera. Depending upon its location, the results may be more or less serious. If situated chiefly in the decidua basalis, more serious consequences would be expected to the fœtus than if it were limited to the decidua vera. The disease may be characterized by a hypertrophy and hyperplasia of the glandular elements or it may be limited to the inter-glandular connective tissue, terminating in an atrophic condition. If the changes begin early in pregnancy, abortion is the usual result ; but when the process pursues a slow course and is not severe, the full term of gestation may be com-

pleted. In such a case, however, adherent placenta, retained membranes, dry labor, and post-partum hemorrhages are frequent complications. Finally, it should be remembered that these changes in the decidua may be important factors in the etiology of abnormalities of the neighboring fœtal appendages.

Certain pathological varieties have been differentiated:

I. *Chronic Diffuse Changes*, in which there is a general hypertrophy and hyperplasia of all the structural elements, so that the entire membrane becomes enormously thickened.

II. *Chronic Polypoid Changes*, in which the hyperplastic tissue is unevenly distributed, producing rounded or polypoid excrescences upon its surface.

III. *Chronic Glandular Hyperplasia*, in which the union of the decidua vera and reflexa is prevented. There is an excessive secretion of watery mucus, constituting what is clinically known as one variety of hydrorrhœa gravidarum. In some instances the glands are so blocked by interstitial changes that cysts are formed of considerable size and number.

IV. *Atrophy.* This is generally regarded as a rare condition, in which the ovular attachments are naturally so imperfect that the pregnancy usually continues only for a short time.

The writer's clinical experience has convinced him that mild grades of this condition are comparatively frequent, occurring in uteri that are relatively infantile, and accounting for many cases which abort with the first pregnancy and go on to full term with subsequent pregnancies. Schaeffer, who has made a histological study of such cases in which a hypoplasia of the uterus existed, concludes that it is a cause of thromboses and necroses of the decidua and chorionic villi which are manifested clinically by abortion, retention of gestation products, hemorrhages, and disturbances of menstruation.

Clinical Course. The diagnosis of a pathological condition of the decidua can hardly be made until the symptoms of a threatened interruption of the pregnancy suggest such as a possible cause. Even then it is impossible to differentiate clinically the pathological varieties, except that form known as hydrorrhœa gravidarum, and possibly the atrophic variety.

Hydrorrhœa Gravidarum. This term is used to express the occurrence of the discharge of a clear, slightly viscid fluid, which escapes from the uterus in amounts varying from a few drops to a pint or more, either continuously or at irregular intervals. This symptom may be the expression of one of two distinct pathological processes, designated, respectively, as hydrorrhœa deciduale and hydrorrhœa amnialis.

Hydrorrhœa Deciduale represents the pathological variety of decidual change that has been described as chronic glandular hyperplasia. The discharge is usually not marked until the late months. There may be no unfavorable results for either the mother or child. The application of all measures that are usually employed to prevent a premature termination of pregnancy is the only practical method of treatment.

Hydrorrhœa Amnialis, more properly, from a pathological standpoint, described under diseases of the amnion, refers to the premature escape of liquor amnii from a high rupture of the sac. Stoeckel believes that this is the pathological condition that is present in the majority of instances

in which hydrorrhœa occurs. According to Stoeckel, it is possible to differentiate clinically the two varieties by the constant occurrence of a hemorrhage in the amnial form, which may or may not precede the appearance of the watery discharge. Hydrorrhœa amnialis gives a more unfavorable prognosis for the child, and the hemorrhage may be enough to jeopardize the life of the mother. The occurrence of a severe hemorrhage is an indication for immediate termination of the pregnancy.

ABNORMALITIES AND DISEASES OF THE AMNION.

The source of the liquor amnii is still a matter of so much uncertainty that the causes for pathological variations in its amount are not definitely known. The efforts of Zangemeister and Messl, by extirpating the kidneys of pregnant animals to substantiate the opinion that it arises from the fœtal urine, are inconclusive, although without doubt a certain amount does come from this source. It seems more probable, particularly from the work of Ahlfield and Polano, that the greater part comes from both the maternal and the fœtal vessels, not, however, as a simple transudate. A recent histological study by Mandl of the morphological elements of the amniotic cells strongly points to their secretory activity as playing an important part in its production. The normal amount at term is estimated as from one to three pints.

Oligohydramnios, or deficiency of amniotic fluid, is generally regarded as a rare condition, but, as suggested by Lomer, all cases in which it is found to be deficient at full term are generally ascribed to a premature rupture of the amniotic sac. There may be only a few teaspoonfuls of fluid present, which is usually of thicker consistence than normal. A marked deficiency of liquor amnii has a deleterious influence upon the fœtus, especially if appearing early in pregnancy, both from the effects of pressure and from the deformities that result from the amniotic adhesions and bands. The skin of the fœtus is apt to be dry, presenting a condition that resembles ichthyosis, which Ahlfeld has suggested as a cause rather than a result. The work of Mandl, suggesting that the secretory activity of the amniotic epithelium lessens or stops in the latter part of pregnancy, is rather corroboratory of Ahlfeld's idea that in a series of cases reported by him the liquor amnii may have disappeared in the late months as a result of some abnormal change in this epithelium rather than from a rupture of the amniotic sac. The diagnosis may be made from the absence of ballottement. The fœtal parts are often difficult to distinguish.

Hydramnios, Polyhydramnios, is that condition in which the amount of liquor amnii is so excessive as to be noticeable and cause symptoms. It is said to occur not oftener than once in 150 or 200 pregnancies; it is more common in multiparæ. In rare instances the amount may be five or six gallons.

Etiology. From the frequent presence of abnormalities in both the mother and the fœtus, attempts have been made to explain its causation.

Abnormalities of the Fœtus. Twin pregnancies, according to Wilson, occur in about one-half of the cases of hydramnios, which is supposed to result from the relation of the vessels in the common placenta. If the vessels of one twin take a shorter course, more blood will go to that fœtus

than to the other. The result is more rapid growth and a larger and more powerful heart. Thus, one child absorbs more fluid from the placenta and produces an excessive secretion from the kidneys, and possibly also from the skin. In other cases, one twin may exert pressure upon the other in such a way that a stasis results in the vessels of the cord, and an increased transudation through their walls results. Marked deformities of the fœtus occur in 10 per cent. of the cases of hydramnios, according to Sallinger, but it is impossible to say whether as cause or effect. Diseases of the fœtus, especially syphilitic affections of the liver, have been ascribed as a cause, but recent evidence tends to show that the children are healthy in a very large number of cases.

Fœtal Appendages. Various diseases of the placenta and decidua are mentioned as factors in the etiology. Twisting of the cord and other abnormalities apparently account for some of the cases. Seitz thinks that further study will show more and more that inflammation of the amnion is an important cause.

Maternal. Various diseases of the mother, especially hepatic and cardiac disease, are said to cause the condition.

Clinical Course. The disease may run a chronic or an acute course. Symptoms do not usually begin before the fifth month.

The *Chronic Form* is the more frequent. The symptoms are mostly referable to the effects of pressure upon the internal organs, chiefly upon the diaphragm, which even in the sixth month may cause palpitation and dyspnœa. Œdema of the lower extremities is almost always present. Other symptoms, such as vomiting, albuminuria, and jaundice, may be the result of pressure; but, in most instances, they are probably the expression of some metabolic disturbance associated with the condition. Emaciation also may be present.

The Physical Signs are such as one would expect from the excessive accumulation of fluid in the uterus, namely: A larger uterus than the period of gestation would suggest; a thin uterine wall; earlier and more marked fluctuation; difficulty in palpating the fœtal parts; absence of fœtal heart, or, if present, very feeble sounds. On vaginal examination the motility of the fœtus is felt to be excessive; the lower segment of the uterus is greatly stretched and the cervix may be somewhat effaced and partly open, as in the beginning of labor. Malpresentations are common and the labor is apt to be premature.

The Acute Form. In this form the excessive accumulation may take place in the course of a few days and the rapid distention cause great suffering; in some cases a rise of temperature occurs. The abdomen may be so sensitive as to preclude palpation without an anæsthetic.

Diagnosis. The condition may be confused with ascites or an ovarian cyst. If the abdominal examination does not make the diagnosis clear, the peculiar relations of the lower uterine zone, as felt through the vagina, will usually enable one to make the diagnosis certain. In an acute case the symptoms may resemble an ovarian cyst with a twisted pedicle or an ectopic pregnancy.

Prognosis for the child is poor, as abnormalities incompatible with life frequently co-exist, and even when the child is healthy the frequent occurrence of a premature birth diminishes its chances of living. The prognosis for the mother is less favorable than in normal cases because

of the frequent necessity for operative interference and the danger of post-partum hemorrhage from failure of contraction of the over-stretched uterine muscle. Toxæmia may also constitute a danger.

Treatment. Medical and dietetic treatment are of little service. In some instances the pregnancy may be carried along until the child is supposed to be viable, but constant vigilance for the appearance of dangerous symptoms is also necessary. Labor should be induced in the acute cases and in all chronic ones in which danger is imminent. It is best accomplished by puncture of the membranes. Especially in the acute cases a sharp lookout for post-partum hemorrhage should be kept up.

Alteration in the Character of the Amniotic Fluid. The appearance of the liquor amnii varies with the period of pregnancy: in the early months it is clear, alkaline in reaction, and with a specific gravity of about 1006. Later it becomes somewhat thicker and whiter from the admixture of epithelial cells and flakes of vernix caseosa; the liquid also contains small hairs from the surface of the fœtal body and shows traces of urea. Substances injected into the maternal circulation may reach the liquor amnii, and in cases of poisoning with the mineral salts their traces have been found in the amniotic fluid. More or less meconium may be mixed with the fluid, giving a dark brown or greenish tinge. The death and maceration of the fœtus may markedly discolor it and give it a fetid or sickening odor. Infection of the intact amniotic sac may occur, as shown by Hellendall: this may be of the greatest importance both to the mother and the fœtus.

DISEASES OF THE CHORION.

It is reasonable to suppose that various changes in the chorion frequently occur, owing to the many possible pathological conditions that may exist in the decidua; but no satisfactory classification has yet been made.

Vesicular Mole, or Hydatidiform Mole, Myxoma Chorii. Under these names is known a degenerative process of the ends of the chorionic villi by which they become converted into translucent cysts, varying in size from a millet seed to a hazel-nut or even larger. These cysts hang by small pedicles and present somewhat the appearance of a bunch of grapes. Some of the cysts are connected with the walls of adjacent cysts, so that several may hang by the same pedicle. The vesicles may be rounded, fusiform, or pyriform. They are distended with a clear, yellowish or pinkish fluid of watery consistence, which contains mucin and albumen. Depending somewhat upon the period of pregnancy in which the disease begins, the extent of the disease varies. If it starts before any of the villi have begun to atrophy, it is apt to involve the entire chorionic surface, so that the uterus becomes entirely filled with these cysts, which, in a case of the writer's, measured two quarts after they were removed. In such an extensive form of the disease no trace of fœtus or amniotic sac can be found. In less marked examples there may be a small collection of gelatinous fluid in which the remains of a fœtus or umbilical cord may be seen. As represented in the figure, there may be considerable decidua left. If only a few cotyledons of the placenta are involved, the child may be born alive at full term.

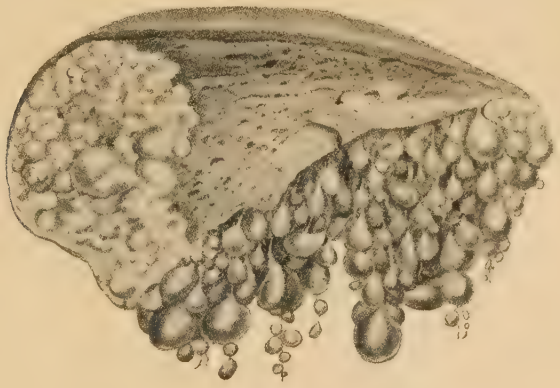
PLATE XX.

Vesicular Mole.

Pathology. Virchow's idea that it is a myxomatous degeneration of the stroma of the villi has now been supplanted by the view, first brought out by Marchand and Fraenkel, that it is essentially a proliferation of the epithelial covering of the villi, both layers of which invade to a greater or less extent the decidua, and the musculature, particularly the intermuscular connective tissue that surrounds the bloodvessels, corroding their walls and occasionally being deported to distant parts of the body. As a result of the nutritional disturbance, hydropic degeneration of the stroma occurs. Gottschalk, however, still believes that the primary factor is due to a disturbance of the fœtal circulation which causes a venous stasis in the villi, the proliferation of the epithelium being secondary to its intimate relations to the maternal blood.

Etiology. *Fœtal Theory.* Gottschalk has observed a narrowing of the umbilical vein in a number of cases in which the fœtus is preserved, and concludes that it is the essential factor in the production of venous stasis in the villi. Kehrer's case is quoted, in which, with a well-devel-

Fig. 236.



Vesicular mole.

oped and living child, one-quarter of the placenta showed a hydatidiform degeneration, the vessels leading to which were obliterated. In some cases of twin pregnancy one ovum may be normal and the other show this cystic degeneration.

Ovular Theory. From the frequent association of double-sided corpus luteum cysts with vesicular mole, the theory has been deduced by several writers, notably L. Fraenkel and Pick, that the ovarian disease is the primary one. According to Fraenkel, the corpus luteum, being a gland with an internal secretion, if the seat of pathological lesions, disturbs the normal relations between the mucosa and the ovum, which it normally maintains. Pick, however, thinks that the excessive production of lutein substance causes the proliferation of the chorionic epithelium.

Decidual Theory. This theory seems the more probable, which is based upon the evidence of the existence of a previous endometritis. Veit has often found a moderate round-celled infiltration in both the decidua basalis and vera.

Its Relations to Malignancy. Cystic degeneration of the chorion is occasionally followed, within a few weeks or months, by that form of malignant neoplasm now very generally termed chorio-epithelioma. Kehrer, however, has collected 50 cases, in none of which did such a tumor subsequently develop. According to Seitz, chorio-epitheliomata have been preceded by the expulsion of a vesicular mole in about 50 per cent. of the cases. The similar histological structure of both these conditions makes it of the greatest clinical as well as scientific importance to consider their relations. Both consist essentially in a more or less lawless growth of the chorionic epithelium which invades the maternal structures to a greater extent, but in a way similar to the normal trophoblast. They may be regarded then as two growths with a similar anatomical structure, one benign and the other malignant; both invade the maternal structures in excess of the physiological amount, the vesicular mole less so than the chorio-epithelioma, although there is no known border line between them, except that the deported cells of the benign growths do not form embolic growths that rapidly destroy their host.

The Differential Diagnosis, therefore, presents considerable difficulty. Among recent writers there is considerable unanimity of opinion that it cannot be made by the microscope alone. Inasmuch as most of the organs from which histological studies have been made were the seat of other conditions, such as cancer, fibroids, and endometritis, and in the only normal uterus that Meyer examined, taken from a suicide, no chorionic invasions were found, he suggests the possibility of their absence unless such lesions are present. From this he makes the practical suggestion that the microscopical diagnosis must depend upon the clinical relations. If the primary tumor is known to have been entirely removed, then the presence of these invasions is significant of malignant change; but if any part of the tumor is retained in the uterus, the presence of epithelial nests beyond the decidua may be only indicative of a benign invasion that is kept up by their presence. In conclusion, then, every vesicular mole must be thoroughly removed and the case observed for several weeks. Recurrence of symptoms should always be regarded as suspicious of malignant changes.

Symptoms. The symptoms usually appear within the first three months of pregnancy. A woman believing herself to be normally pregnant begins to have irregular discharges of blood from the vagina which are not usually severe, but are followed by an odorous serous discharge. She begins to feel bad; the appetite is poor; there may be more than usual nausea and vomiting; the color of the skin is pale; œdema of the lower extremities frequently appears; there is loss of flesh and strength —all of the evidences of a malignant growth associated with pregnancy. If seen early these signs may not be so marked. The *examination* usually reveals the presence of albumen and casts in the urine. The uterine wall seems to lack the normal muscular tone and may feel doughy. The diagnosis may be impossible before the expulsion of some of the uterine contents, which is very rare until the process of expulsion has actually begun.

Prognosis. The minor forms of the disease, in which the child lives, are very rare. For the mother the dangers are hemorrhage,

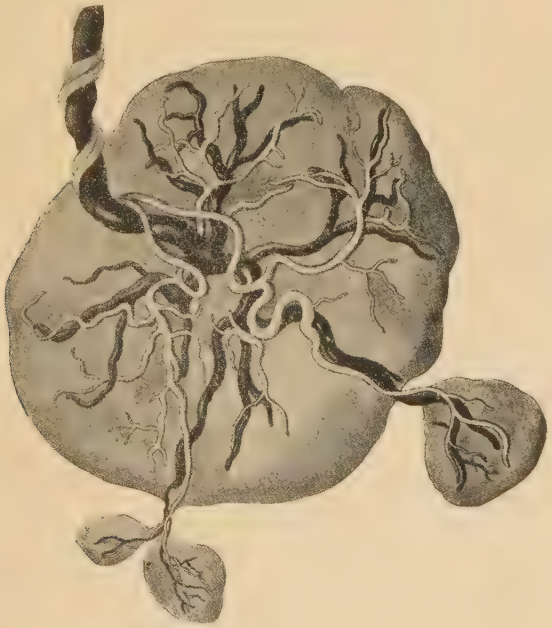
infection, toxæmia, perforation of the uterus, and subsequent malignant disease.

Treatment. When the diagnosis is established the indication is to immediately empty the uterus. After dilating the cervix, either manually or by means of instruments, the contents are best removed by the fingers, aided by counter-pressure over the abdomen, because the uterine wall in this condition is easily perforated. Hot intra-uterine irrigations with a weak iodine solution, followed by a thorough packing with sterile gauze, will best prevent hemorrhage.

ABNORMALITIES AND DISEASES OF THE PLACENTA.

Anomalies of Size and Shape are very common. The *size* varies in general with the size of the child, weighing between one-fifth and one-sixth of that of the child. Its thickness is inversely proportional to its extent. A thin placenta may extend almost entirely around the amniotic sac, owing to a persistence of all the chorionic villi, and is termed *placenta membranacea.*

Fig. 237.



Placenta with three succenturiate placentas. (Bumm.)

The *shape*, instead of being oval, may be very irregular, in rare cases even crescentic or horseshoe-shaped. When several cotyledons are excessively developed it is said to be multilobular. If the cord, instead of being inserted at the centre, joins the placenta at the margin it is called a *battledore placenta.*

Multiple Placenta. There may be two or more placental masses of almost equal size or there may be accessory placentæ consisting of only a

few cotyledons—*placenta succenturiata*. The accessory placentæ are connected by a bridge of membranes upon which run the vessels from the umbilical cord. *Placenta spuriæ* are groups of villi having no relation with the maternal blood-stream. The danger of leaving a portion of the placenta in the uterus makes all of these anomalies of shape of great clinical importance. If the membranes appear torn away near the placental margin they should be washed and held up to the light in order to see if they contain the portions of ruptured vessels running to an accessory placenta.

Placentitis. Inflammation of the placenta can only be imperfectly classified. Its intimate relation, however, with the uterine decidua would suggest that it must frequently be the seat of pathological changes.

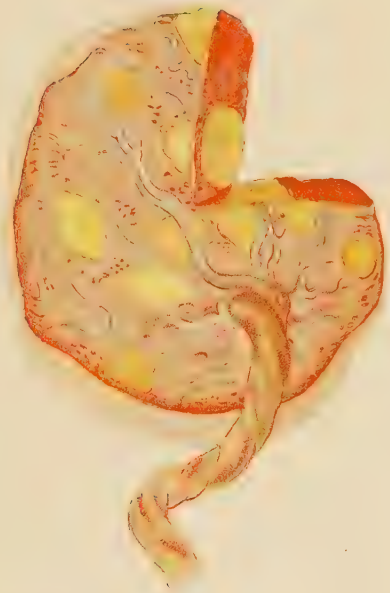
Acute Inflammation. A few examples of acute inflammation of the placenta, due to bacterial invasion, are reported. Of five placentæ taken from women known to be infected with gonorrhœa, which were examined microscopically by Wollstein and reported by McDonald and the writer, two showed a placentitis that was limited to circumscribed areas. Both patients showed marked constitutional symptoms in the puerperium.

Chronic Inflammation. As with the decidua, the changes in the placenta are mostly of a chronic character, consisting of connective-tissue changes around the vessels. Outside of syphilis and tuberculosis the causes are obscure, but it is probable that general diseases of the mother predispose, at least, to circulatory disturbances in the placenta.

Syphilis of the Placenta. The efforts to trace the source of the infection—whether from the father or the mother—or to tell the time of its inception, relative to the pregnancy, from changes in the placenta, are practically futile. Certain changes do occur that are rather characteristic of its presence. If the placenta is markedly syphilitic, its size and weight are much increased ; the color is paler, the consistence is harder, and the divisions between the cotyledons are less distinct than normal. Microscopically, the villi are more plump and the ends are club-shaped. The stroma is filled with granulation cells and the intervillous spaces are smaller. An endarteritis is also present, causing in some vessels an obliteration of their lumen. There is an appearance of some inclusion of the syncytial cells in the stroma and proliferation on the surface of the villi. Changes in the placentæ of syphilitics are not always present. They were absent in 82 out of 160 observations made by Mracek.

Tuberculosis of the Placenta. According to Warthin, and supported by Welch and Trudeau, there is cumulative evidence that placental tuberculosis is more common than is generally supposed and that it is a fact the disease can be transmitted through the placenta. Gross tuberculous lesions of the placenta have not been described, but the microscopical evidence in the form of tubercles in the intervillous spaces, on the surface and in the stroma of the villi, has been shown by Schmorl, Birch-Hirschfeld, Kockel, Warthin, and others. A tuberculous inflammation of the decidua was the source of the infection of the placenta in some of the cases, while in the majority, according to Seitz, it had undoubtedly arisen directly from the maternal blood in the course of an acute miliary tuberculosis. According to Bossi, infection of the child occurs through tuberculous disease of the decidua.

White Infarcts of the Placenta. According to Williams, infarcts of



microscopic size are found in every placenta, and in 63 per cent. they are found measuring one centimetre or more in diameter. They are usually whitish or yellowish white in color, more or less sharply defined from the surrounding tissue, and may be located in any part of the placenta, but more often near the edge.

Placenta Marginata is classified by Seitz and Williams as an infarct. In this variety the membranes do not cover the entire fœtal surface, but leave a margin which may be the seat of numerous blood clots, or later be marked by a circular whitish band that may entirely surround the placenta; a healthy placental zone may develop just beyond this band. If the edge of the placenta appears as slightly turned up it is termed *placenta circumvallata*. By many observers this band is thought to be the result of inflammation of the decidua causing a thickening at the junction of the vera and reflexa. None of these forms are of much clinical importance unless they are of such size and number as to interfere with the function of the organ. They are often spoken of as areas of fatty degeneration.

Mode of Origin. The original researches of Ackermann, subsequently confirmed by Williams and others, show with reasonable certainty that the process is a coagulation necrosis from an obliterating arteritis in the vessels of the chorionic villi, all parts of which are finally included, so that few, if any, villi can be recognized. Associated with the changes in the villi is coagulation of the blood in the intervillous spaces and fibrin formation. Seitz thinks that Steffeck's theory, that the primary lesion is an inflammatory process of the decidua, accounts for the formation of the majority of those infarcts that are located in the intervillous spaces of the serotina. He regards the chorionic necroses as a physiological process incident to senile changes in the placenta, while the intervillous infarcts are distinctly pathological.

Red Infarcts, so-called from their pinkish or red color, are less frequently observed. They are of irregular shape, of varying size, and most often seen upon the maternal surface. Their association with a chronic nephritis and with the death of the fœtus makes them of considerable clinical importance, although their mode of formation is unknown. A toxæmia is often present, although they are not usually seen in eclamptic cases. Hemorrhagic masses surrounded by a fibrinous capsule are commonly termed apoplexy of the placenta.

Tumors of the Placenta are very rare. They all arise from the stroma of the chorionic villi. Hypertrophy and hyperplasia of the bloodvessels are prominent features. When present, they are chiefly of clinical importance, because through circulatory changes the child is frequently born prematurely and dead. They also may be of some danger to the mother through the tendency to cause post-partum hemorrhage.

Cysts of the Placenta. Cysts usually of small size are frequently seen upon either surface of the placenta and less often in its substance. They are of little clinical importance, but from a scientific standpoint they are of interest because, similarly to the mode of formation of the white infarcts, there has been considerable discussion as to whether degeneration of the villi or of the decidual cell is the primary factor in their causation. Runge, contrary to most of the recent workers, maintains the latter theory. It is generally agreed that the amnion has no relation

to their formation. Some of them are undoubtedly the result of softening of the centres of infarcts.

Calcareous Degeneration is a common occurrence, and like most of the infarcts is of no pathological importance, simply representing senile changes of the organ. It is seen usually as small sand-like bodies scattered over the maternal surface.

ANOMALIES OF THE UMBILICAL CORD.

Length. The normal average length of the cord is from 40 to 60 centimetres. It may be very short or very long. It may be relatively short from the presence of numerous coils about the fœtus, and cause the same dystocia as when it is absolutely short. In cases with very short cords delivery only occurs, according to Brickner, after one of the following accidents: separation of the placenta, inversion of the uterus, or rupture of the cord.

Insertion. In 2000 placentæ examined at Johns Hopkins, the insertion of the cord was eccentric at 73.25 per cent., central in 18.25 per cent., and marginal in 7.25 per cent. *Insertio velamentosa*, in which the cord terminates in the membranes, the vessels continuing their course to the placenta through these structures, may be a source of danger to the child from rupture of the vessels.

Coils. It is common for the cord to be coiled once or twice around the child's neck, but danger from strangulation is only present in cases of breech presentation.

Knots are distinguished as true and false, the false knots representing developmental peculiarities, while the true knots are the result of movements of the child, especially in cases with long cords and an excessive amount of liquor amnii. They are occasionally the cause of death of the fœtus. In twin pregnancies with one amniotic sac the two cords have become united in so firm a knot that death of both children has resulted.

Torsion. The cord naturally displays an apparent twisting from left to right and occasionally there is an actual torsion, which may be dangerous to the child. The seat of the torsion is usually at the umbilicus. The fœtus is found dead in all cases of pronounced torsion, and the excessive twisting is recognized as a result and not as a cause of the fatality.

Navel Cord Hernia. A protrusion of the contents of the abdominal cavity at the point of insertion of the umbilical cord occasionally occurs. It is the result of arrested development and is often associated with other deformities. The contents of the sac are usually omentum and intestine. During the separation of the cord a dry dressing must be applied with sufficient pressure to prevent protrusion of the hernia. Operative treatment is necessary.

Inflammation of the Cord. Most commonly the changes affect the vessels, especially the veins. As a result there is marked narrowing of their lumen, causing death of the fœtus in many instances. Syphilis is a frequent cause, but, unlike the productive lesions in placental syphilis, inflammatory exudate of round cells is commonly present.

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CHAPTER XIV.

PATHOLOGY OF THE FŒTUS.

ANOMALIES.

FŒTAL anomalies were objects of much interest in prehistoric times. Medicine was then a conglomeration of astronomy, astrology, theurgy, legend, and charlatanism. The great kings of Babylon were conquerors, priests, and physicians. Somewhere about the year 720 B. C. Sargon I.[1] of Agade and his son, Naramsin, reigned and practised medicine.

FIG. 238.

Anencephalus as an example of probable amniogenetic anomaly, left club hand. (After SCHWALBE.)

Sargon I. edited a great astronomical work, which was a standard until the victories of the Greeks in Babylonia. Astrology and star-gazing originated during this period probably, together with prophecies. That anomalies played an important part in the medicine of these times is evidenced by the following quotation from tables in the library at Nineveh, ascribed to the pen of Naramsin: "When a woman bears a child with lion's ears, a great king shall be in the land. When a woman bears a child without a right ear, the days of the prince shall be long. When a woman bears a child without ears, mourning shall be brought into the

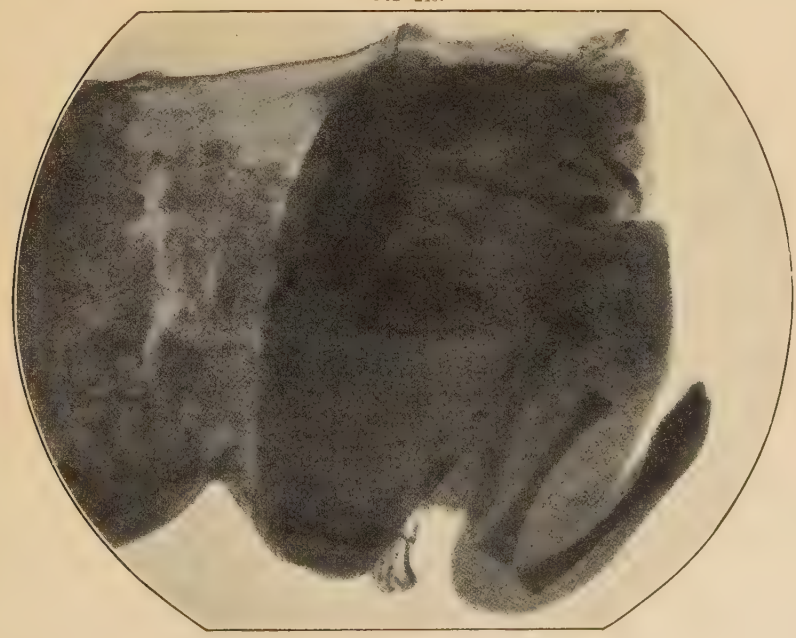
[1] Puschmann: Handbuch der Geschichte der Medicin, p. 53—von Oefle's art.

FIG. 239.

Amniogenetic anomaly. Tight amnion. Right leg fastened to head with a broad amniotic band. (After SCHWALBE.)

land, which shall become smaller. When a woman bears a child whose right ear is too small, the house of her husband will be destroyed. When

FIG 240.



Radiograph of Fig. 239. Observe angulation of vertebræ

FIG. 241.

Amniogenetic anomaly. Five months' fœtus. Anomalous development of both hands with amniotic strands attached. (After SCHWALBE.)

FIG. 242

Fœtus with multiple amniogenetic malformations. Exencephalon with partial acrania, bilateral cleavage of lips and palate, and malformation of extremities. (After SCHWALBE.)

FIG. 243.

Amniogenetic anomaly. Shows nearly all the amniotic anomalies. (After MARCHAND.)

a woman bears a child with the beak of a bird, peace shall endure in the land. When a woman bears a child without a mouth, the woman of the house must die. When a woman bears a child without fingers on the right hand, the master will be captured by his enemies. When a sheep bears a lion, the arms of the king will be victorious; and he will not have his equal."

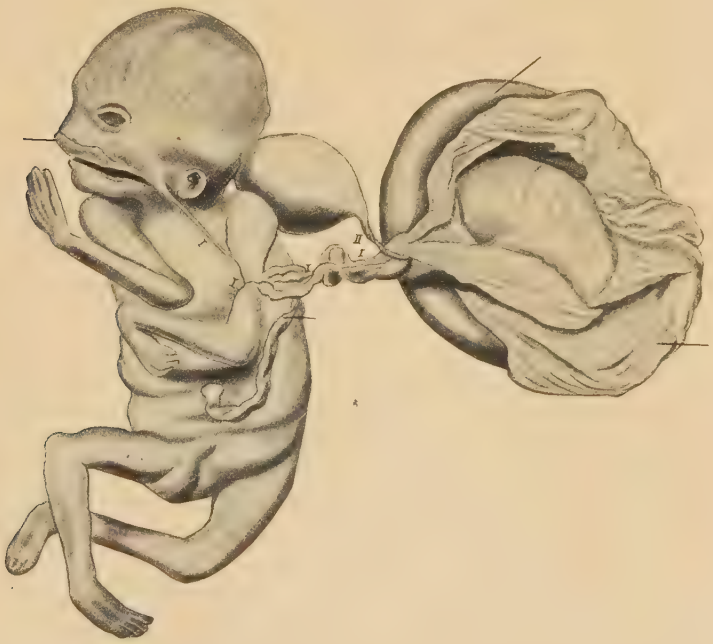
That anomalies were very common among the ancients is probable by virtue of the facts of their mode of life and sexual excesses.

Fig. 244.

Five and one-half months' fœtus with bilateral cleavage of lips. At *a* is an amniotic tag.

Fœtal anomalies are to-day believed to result from two principal causes: (*a*) Defects in the sexual cells, either before, during, or after their conjugation, or after fertilization is completed and segmentation of the ovum has begun. (*b*) Altered conditions in the womb during the period of utero-gestation.

Fig. 245.



Multiple amniogenetic anomaly. Involves the left angle of the mouth *I* and arm *I*. The umbilical cord *I* and *II* an occipital encephalocele attaching it to fœtal placenta. (After Winckel.)

Under the first class come certain cases of defective development of fingers and toes, hare-lip, cleft palate, hemophilia, blighted ova, etc.,

where heredity often enters as a factor. After segmentation of the ovum begins the new cells may become injured. This may occur at any moment; so that, aside from the degree of the injury, its gravity will depend upon whether it involves an early or late generation of embryonic cells. Obviously the ultimate effect upon fœtal development will be greater in proportion as the injury occurs earlier in the process of segmentation; *e. g.*, the same degree of injury would produce a much more profound effect upon oval development if it occurred in the second than if it took place in the sixteenth or sixty-fourth generation of cells, or if,

FIG. 246.

Deep cleavages of face, opening of abdomen, club foot. Note the amniotic band inserted at angles of fissures and passing above the forehead. (After WINCKEL.)

after differentiation of the somatic cells, one or more cells of a single group were damaged. The quality of these injuries is, for the most part, obscure; but there can be no doubt that the underlying causes are physical, chemical, and mechanical in their nature, and that they operate to inhibit cell growth. The great obstacles to accurate observation of the operation of these causes render our knowledge of the resulting fœtal anomalies less fundamental than it is of those coming from the second class of causes—*i. e.*, altered conditions *in utero* during gestation. In the palmy days of the Alexandrian school, Hippocrates, Erasistratus,

PLATE XXII.

Acephalus. (Hirst and Piersol.)

PLATE XXIII.

Acephalus. (Hirst and Piersol.)

PLATE XXIV.

Pseudencephalus. (Hirst and Piersol.)

PLATE XXV.

Anencephalus. (Hirst and Piersol.)

PLATE XXVI.

Anencephalus. (Hirst and Piersol.)

PLATE XXVII.

Cyclocephalus. (Hirst and Piersol.)

(Cyclops.)

PLATE XXVIII.

Skeleton of Cyclocephalus. (Hirst and Piersol.)

PLATE XXIX.

Phocomelus. (Hirst and Piersol.)

FIG. 247

Wide adhesion of amnion with the surface of head. Defective formation of skull bones. (After WINCKEL.)

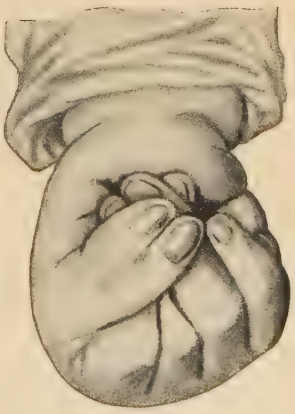
and other eminent Greek physicians regarded uterine displacements as the cause of fœtal anomalies and abortion. Maternal impressions seem to be the only cause assigned for fœtal anomalies up to within a comparatively recent date.

The more exact data of modern embryology, physiology, and pathology have done much to place the subject upon a scientific basis.

It is certain that defective development of the fœtus may result from :

1. Pathologic conditions of the uterus.
2. Pathologic conditions of the placenta and cord.
3. Pathologic conditions of the fœtal membranes.

FIG. 248.



Cleavage of right thumb. (After WINCKEL.)

FIG. 249.

Amniotic bands on toes. (After WINCKEL.)

FIG. 250.

Amniogenetic anomaly. (After WINCKEL.)

4. Increased or diminished amniotic fluid.
5. Combinations of two or more of these. The best understood

anomalies of this class are due to defects of the amnion and amniotic fluid. These are well illustrated in Figs. 238–250. They result from adhesions of the amnion to the fœtus, traction on the fœtus of adherent amniotic bands, pressure of a tight amnion over a large area, and constriction by strings of membrane, which may thus produce amputations of whole members.

Oligohydramnios, with pressure and fœtal-amniotic fusion, may persist or be superseded by great increase of amniotic fluid and traction upon the fœtus at adherent points. The amniogenesis of many monstrosities is distinctly seen; others require close inspection to establish it.

Under malformations are included all imperfect, deviating formations of the entire body or its parts which can be attributed to malposition in the uterus or deviation from normal intra-uterine development. Those minor deviations of development which occasion no marked change of form and no disturbance of function are simple anomalies. Those malformations which produce remarkable deformity of the body are monsters. Of these there are three great groups: 1. Monstra per defectum. 2. Monstra per excessum. 3. Monstra per fabricam alienam. These are again divided according to origin and according to outward resemblance into a large number of subdivisions.

Monstra Per Defectum

Are malformations characterized by lack of, or incomplete, development.

I. The defect is the principal characteristic: simple anomalous formation.

A. Absence or stunting of large sections of the body.

1. Amorphus, Acardiacus amorphus; a formless mass covered with skin.
2. Mylacephalus: Vertebræ, ribs, and pelvis present; no heart; extremities indicated; also head, by a lump.
3. Acephalus (Plates XXII. and XXIII.): Abdominal portion of body, with one or two extremities, and various-sized portions of vertebræ; occasionally with upper extremities, and a rudimentary head. When present, the thorax is open anteriorly; the heart is always absent. Other internal organs are present or absent.
4. Acormus, bodyless (Figs. 251, 252, 253). Head with imperfect brain. Cord inserted in vicinity of throat.

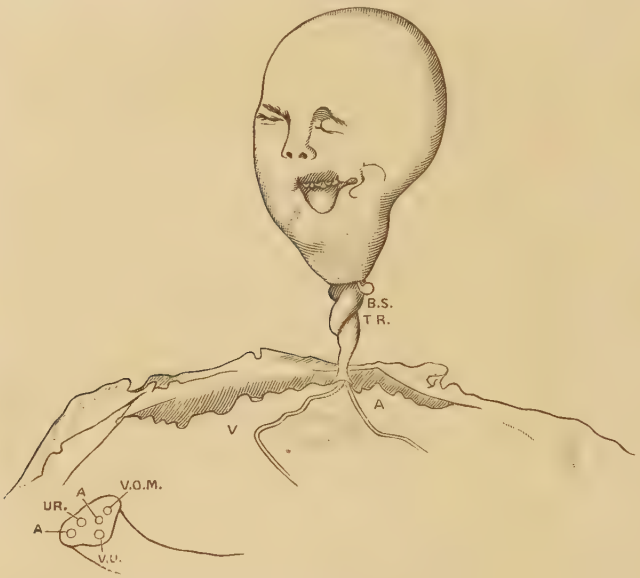
B. Absence or stunting of separate parts.

a. Head.

1. Acrania (Plates XXIV., XXV., and XXVI.): Defective vertex, usually associated with anencephalus; defective brain, and partial defect of the skin. The base of the skull is greatly shortened. Originates through superficial synechia of fœtal head and amnion, or as a result of fœtal hydrencephalocele. Acrania is also occasionally associated with pseudoencephalocele.
2. Hemicrania: Frontal, occipital, and parietal bones rudimentary. Brain rudimentary or absent; in the latter case usually associated with pseudoencephalocele.
3. Microcephalus: Brain small in consequence of premature ossification of skull bones.

4. Cretinismus: Too short skull base, from premature ossification of the synchondrosis sphenobasilaris.

FIG. 251.



Acardiacus acormus. (BARKOW.)

bs. Rudiment of the left upper extremity. *tr.* Rudiment of intestine. *a, a, a.* Arteries. *v.* Vein. *v. u.* Umbilical vein. *v.o.m.* Omphalo-mesenteric vein. *ur.* Urachus.

FIG. 252.

FIG. 253.

Acardiaci acormi. (AHLFELD'S Atlas.)

5. Cyclopia (Plates XXVII. and XXVIII.): Both orbital fossæ are apposed or confluent, or there is one eye which lies in one fossa in the median line. In the higher grades the ethmoid, nasal septum, and vomer are absent. The optic chiasm and

tract persist or are absent. In the brain single parts, as convolutions, thalamus, or olfactory nerve, are wanting, or it terminates anteriorly as a simple bladder.

FIG. 254.

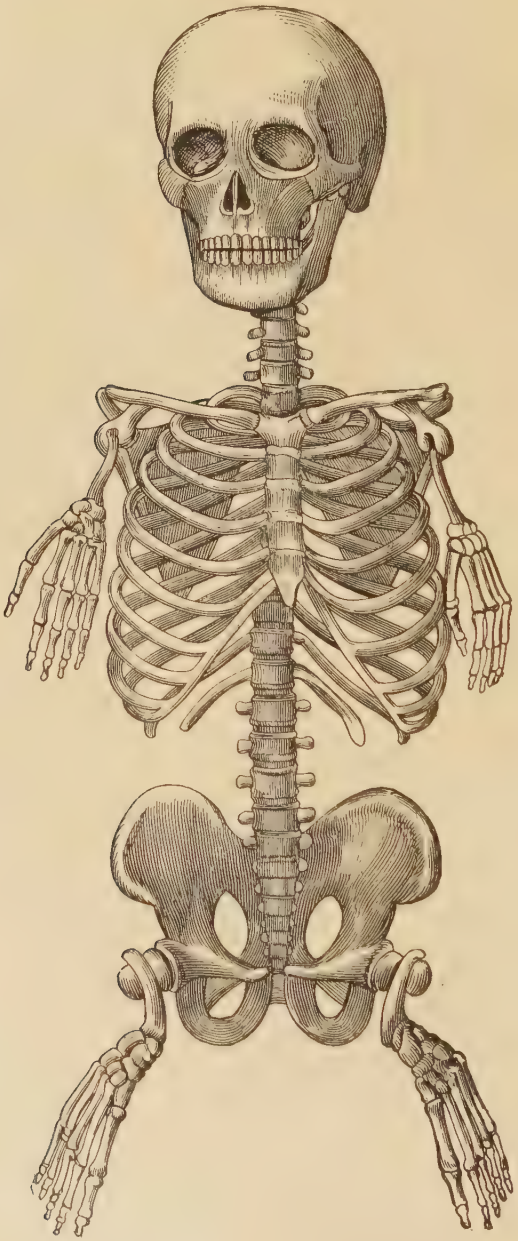
Hemimelus. (HIRST and PIERSOL.)

6. Agnathia: Anomaly of under jaw, or absence of the lower jaw processes of primary blastoderm. Usually the upper jaw, palate, and sphenoid bones are stunted; the ears approach each other, touching at their under surfaces.

7. Aprosopus : Malformation of larger or smaller portions of the face—*e. g.*, nose, mouth, eyelids.

β. Vertebral column, cord, chest.

FIG. 255.



Skeleton of a phocomelus. (Musée Dupuytren.)

1. Amyelie: General or partial defect of the spinal cord; originates from hydromyelocele.
2. Absence of several ribs and vertebræ.

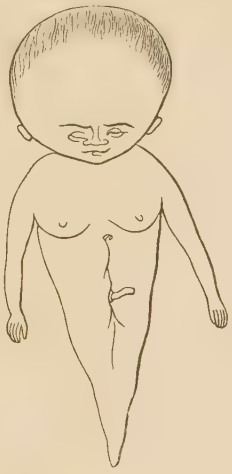
γ. Pelvis and extremities.

1. Amelus: Absence of all the extremities.
2. Peromelus: Malformation of all extremities.
3. Phocomelus (Plate XXIX. and Fig. 255): Hands and feet rest on the shoulders and hips.
4. Micromelus: Abnormally small limbs.
5. Abrachius: Absence of arms.
6. Perobrachius: Defective hands and forearms on normal arms.
7. Microbrachius: one or both arms too small.
8. Monobrachius: Absence of one upper extremity.
9. Sympus (Figs. 256 and 257), Syren formation: Fusion of lower extremities; pelvis and sacrum wanting; atresia of urethra and rectum.

FIG. 256.

Uromelus. (Sympus monopus. FORSTER.)

FIG. 257.



Strenomelus. (Sympus apus. FORSTER.)

10. Apus (Fig. 258): Lower extremities absent.
11. Monopus (Fig. 259): One lower extremity absent. The corresponding half of pelvis also absent (prolapse of intestine).
12. Peropus: Stunted formation of one or both lower extremities.
13. Micropus: Lower extremities small.

δ. Internal organs, intestines: The absence of entire organs is common with malformations of head, and without a heart. It may occur without these anomalies.

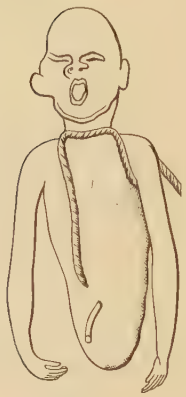
Absence of nose in cyclopia.

Absence of lungs, with absence of diaphragm, and fœtal hydrothorax.

Absence of lips: Acheilia.

Absence of tongue: Aglossia, usually with agnathia.

Fig. 358.



Apus.

Fig. 359.

Monopus.

Absence of gall-bladder; the ductus hepaticus is abnormally wide.
Absence of one kidney; synchronous compensatory hypertrophy of the other.
Absence of urethra, with cloaca formation.
Absence of urinary bladder; ureters open directly into urethra.
Absence of one or both ovaries.
Absence of uterus.
Absence of one or both tubes.
Absence of external female genitals.
Absence of vulva alone.
Absence of hymen alone.
Absence of one or both mammary glands, commonly with synchronous absence of ribs.
Absence of nipples.
Absence of prepuce.
Absence of penis.
Absence of one or both testicles.
Absence of seminal vesicles.
Absence of pericardium, with ectopia cordis.
Partial defect is found in the brain; *e. g.*, absence of corpus striatum.
Absence of septum narium.
Absence of inferior turbinated.
Absence of epiglottis.
Absence of superior segment of œsophagus, and blind ending of pharynx.
Absence, partial, of trachea, with communication with œsophagus.
Absence of tracheal cartilages, generally with abnormal fusion.
Absence, partial, of one lung, with compensatory hypertrophy of the other.
Absence of frænum linguæ, with fusion of tongue with floor of mouth. The frænum may be simply too short.

Absence of middle segment of œsophagus with sac-like dilatation of the superior end; commonly communication with trachea.
Absence of colon and rectum.
Absence, partial, of urethra, in epispadias, hypospadias.
Absence, partial, of hymen; hymen is cribriform, fimbriated, or abnormally wide.
Absence, partial, of spermatic cord.
Absence, partial, of prepuce, short frænum, phimosis.
Absence, partial, of heart.

1. Simple muscular sac, with veins.
2. A chamber with arteries, and auricle and primitive veins.
3. Two auricles, one ventricle; aorta, primitive, gives off pulmonary veins.
4. Two ventricles and auricles. Atresia of ostium aorticum, patency of septum ventriculorum and foramen ovale. Pulmonary artery empties into aorta. Aorta descendens absent.
5. Aorta ascendens and descendens not associated; the latter communicates with pulmonary artery through ductus Botalli.
6. Arteria pulmonalis narrow, closed, or absent; its branches communicate with aorta.
7. Both arteries abnormally narrow; heart-cavities greatly dilated, septum incomplete.
8. Situs transversus of the aorta and pulmonary artery.
9. Patency of foramen ovale, ventricular septum, and ductus Botalli.
10. Anomalous formation of valves; increase or diminution in their number.

C. Abnormal smallness.

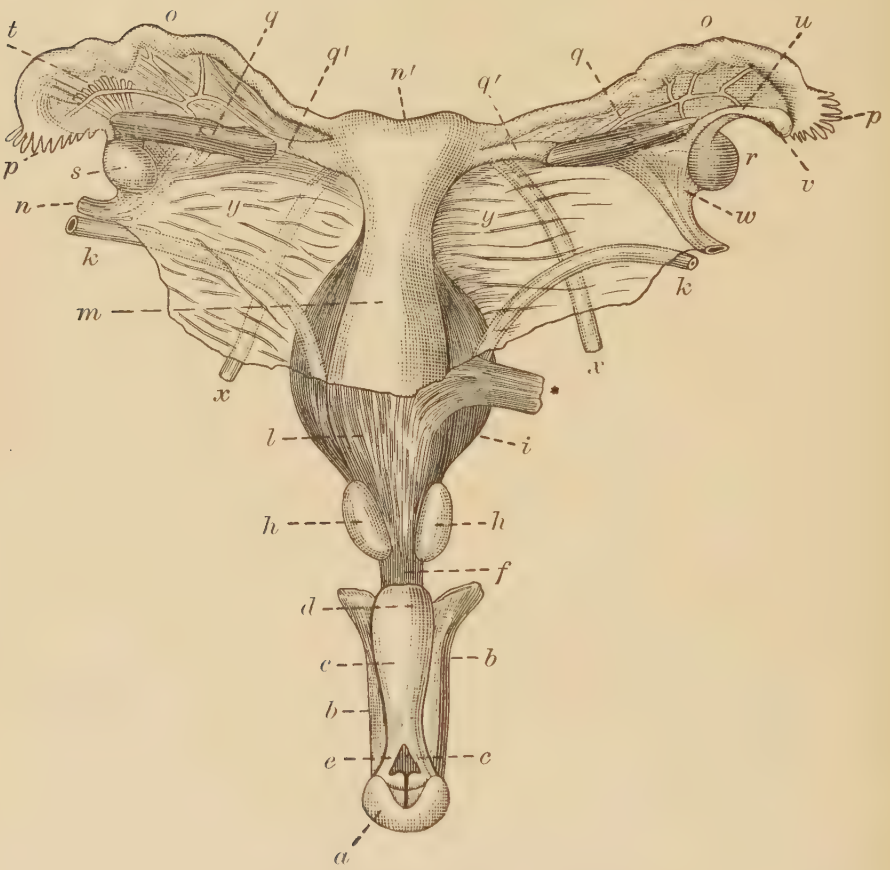
1. Dwarfs (Nansomia, Microsomia): Fully developed individuals under 112 cm. Generally the head and trunk are of relatively unequal size. Occasionally all parts are in proportion.
2. Single parts abnormally small: Heart and bloodvessels (hypoplasia in chlorotics); lungs (in diaphragmatic hernia and dystocia of abdominal organs into thorax); brain (microcephalus), spleen, thyroid, lips, tongue, frænum, stomach, penis, testicles, toes, ears.

II. Arrested development characterized by disturbance of the normal metamorphosis of an originally properly segmenting ovum: No defect, but metamorphosis of part or organ in normal position, with derangement of its component parts.

1. Formation of two or three renal pelves, through unusual arrangement of the separate renculi of the kidney; also lateral disposition of the pelves.
2. Fusion of all the renculi, to form one kidney: Horseshoe kidney. The fusion is usually on the inferior pole, and occasionally associated with dystocia in the pelvic cavity.
3. Communication between trachea and œsophagus.
4. Communication between rectum and vagina (cloaca formation).

5. Hermaphroditismus. (Fig. 260.) There are two varieties—true and false. In the former, male and female generative organs are present; in the latter, there are a male or female generative canal and either male or female genitalia. Of the true variety there are three forms:

FIG. 260.



Hermaphroditismus bilateralis. (HEPPNER.)

a. Glans penis. *b*. Corp. cavernosa penis. *c*. Corp. cavernosa of urogenital canal. *d*. Its bulb. *e*. Its anterior arm. *f*. Membranous part of urogenital canal. *h*. Prostate. *i*. Bladder. *k*. Ureters. *l*. Vagina. *m*. Uterus. *n'*. Fundus uteri. *o, o*. Tubes. *p, p*. Their infundibula. *q, q*. Ovaries. *q', q'*. Ligaments of ovary. *r*. Right testicle. *s*. Left testicle. *t*. Left parovarium. *u*. Right parovarium. *v*. Hydatid of Morgagni. *n, w*. Bloodvessels. *x, x*. Round ligaments. *y, y*. Broad ligaments. ***. Muscle fibres from bladder and vagina.

1. Bilateral: Ovaries and testicles on both sides.
2. On one side, an ovary; on the other, a testicle.
3. Unilateral: On one side, testicles; on the other, ovaries.

Of the pseudohermaphroditism (Fig. 261), two forms—*i. e.*, male and female:

1. Male pseudohermaphroditism (with testes) falls into three subdivisions:

(*a*) Complete: Testicles present; tubes, uterus, vagina, and female external parts.

(*b*) Externus: Testes and male genital canal, with female external parts.

(*c*) Internus: Persistence of Müller's ducts, rudimentary vagina, uterus, and tubes; testes and male external parts.

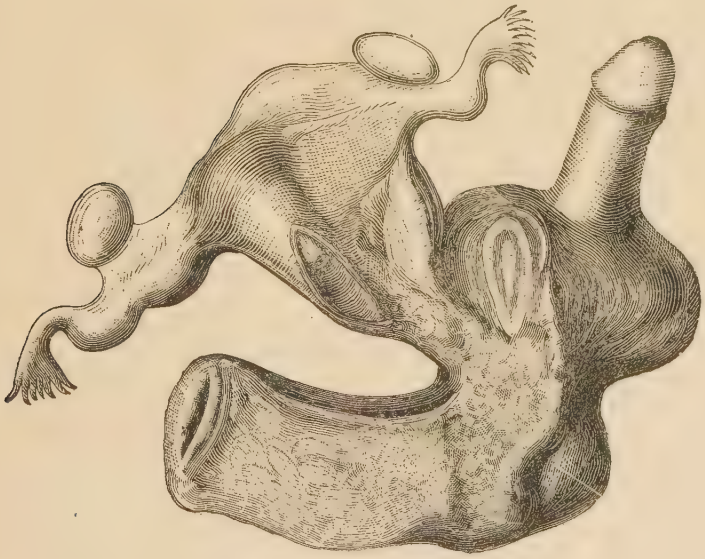
2. Feminine pseudohermaphroditismus (with ovaries) falls also into three subdivisions:

(*a*) Complete: Ovaries, persistent Wolffian ducts; male external genitals.

(*b*) Externus: Ovaries, internal female genital canal, external male organs.

(*c*) Internus: Ovaries; external female genitals; persistent Wolffian ducts.

FIG. 261.



Spurious hermaphroditism. The round bodies are testicles. (After HIRST and PIERSOL.)

In hitherto observed cases of the true variety, functionally active male and female organs were not present; the testicles or ovaries were stunted. The majority of the false variety belong to the male sex. The indefinite location of the organs of generation, and the indefiniteness of all external appearances—voice, beard, breasts, sexual instincts.

III. Arrest of development with prevention of complete ripening of the embryo: Persistence of a certain stage in development.

A. Duplex uterus and vagina through incomplete fusion of Müller's ducts, or through stunting of the same. Rarely the uterus and adnexa fail completely; usually a solid rudiment obtains. Uterus unicornis arises from absence or stunting of one Müller's duct.

B. Cleavage: Most of the cavities and canals of the body are originally plates, which bend to form rings in the first month; and by

apposition and fusion of their edges, complete the cavities and canals. Hinderance of this apposition and fusion results in cleavage of the part. Lips, jaws, palate, neck, trachea, intestines, bladder, skull, vertebræ, thorax, and abdomen may thus remain separated. Cloaca formation consists in arrested development, resulting in communication between rectum, bladder, and the genital canal; this arrest of development occurs from the fourth week of embryonic life to the middle of the third month.

1. Cranial and vertebral cleavage: Cranioschisis, rachischisis, craniorachisis are in small part due to embryo-amniotic adhesions, mostly to lesions of the central nervous system, which are traced to the meninges. Œdema of the cerebro-spinal arachnoid (hydromeningocele cerebralis and spinalis) or ectasia of the ventricles and central canal of the cord (hydrencephalocele, hydrocele medullæ spinalis) either prevents fusion of the posterior vertebral arch or leads to resorption and perforation of the bones. Spina bifida is in rare cases a pure hydromeningocele spinalis, as a rule only in the inferior portion of the cord: hydromeningocele spinalis sacralis or lumbosacralis. When the cleavage is situated higher up there is usually a hydromyelocele. This is as a rule associated with marked stunting, with usually complete interruption of the cord. The spinal processes usually fail completely in spina bifida. Occasionally anterior vertebral fissure occurs with spina bifida. As a rule the protruding sac has in its centre a funnel-shaped deepening. This is the place of fusion with the inferior end of the spinal cord. Hydrencephaloceles, with and without cerebral atrophy, are located usually in the median line, most commonly complicated with spina bifida atlantis or cervicalis. Through pressure the adjacent areas of brain and cord are destroyed. When the sac is very vascular it forms at the base of the skull a red, spongy mass: fungus cerebri, pseudoencephalocele.
2. Cleavage of lips, jaw, and palate (Plate XXIX.). Wolf's jaws: chelio-gnato-palato-schisis, single or double sided, through imperfect conjunction of upper jaw and palatal processes; the first with the anterior end of the frontal process to the middle jaw and vomer. The fissure stretches through the lip, upper jaw, and palate. The soft palate and uvula are cleft in the middle. There is open communication between nose and mouth. This anomaly is present in cleavage of chest and abdomen. The upper lip and jaw can be simply cleft—unilateral or bilateral. The cleavage can extend to the nares. In hare-lip either a fissure or cleavage obtains, which in the latter case can reach the nares. Hare-lip is oftener left-sided; but may be bilateral.
3. Fistula colli congenita is a lateral or median opening, about 2.5 cm. above the sterno-clavicular joint, on the inner border of the sterno-mastoid. The opening is very small, and covered with ciliated epithelium, and has a blind end, which is occasionally sacculated. Lateral fistula is resultant from hindered closure of the third and fourth embryonic plates; the median

fistula, from absence of conjunction of the third and fourth embryonic plates.

4. Cleavage of chest and abdomen lies always in the anterior median line of the body. Through hinderance of juncture of the visceral plates the entire thorax and abdomen to the navel are cleft. The thoracic and abdominal viscera are then displaced forward. In simple thoracic cleavage ectopia cordis is usual. Sternal fissure is the least degree of thoracic cleavage. Gastroschisis, or abdominal cleavage, may stretch from manubrium to symphysis, ensiform to the pubis or navel. In the latter case, separation of cord, omphalocele, or umbilical hernia of the cord is present. If the abdominal cleavage reaches the pubis, vesical cleavage is also present.
5. Vesical cleavage: Ectopia vesicæ urinariæ is characterized by the appearance of the posterior bladder wall through a cleft abdominal wall. The urethra is also occasionally cleft and forms an open border leading to the upper surface of the penis —epispadias. Usually cleft bladder is associated with imperfect fusion of the symphysis, absence of clitoris and vagina, vaginal atresia, and stunting of penis.
6. Intestinal cleavage: Fissura intestinalis congenita is a rare complication of abdominal cleavage. Here, as in vesical cleavage, an open cæcum or colon ascendens appears in the abdominal cleft.
7. Cloaca formation:
   1. With abdominal and vesical cleavage: Abdominal viscera protruded and surrounded by a sac, on the under surface of which is seen the cloacal orifice. The intestinal opening is located above in the centre of the cloaca; the colon terminates blind or is absent; the ureters open in the bladder, also the seminal vesicles, or, in females, the separately developed Müllerian ducts.
   2. With vesical cleavage: In the centre of the cleft bladder is the intestinal opening; on the sides, the opening of the ureters, and seminal vesicles, or vagina.
   3. With closed bladder: Rectum absent (atresia ani); rectum communicates with urinary or genital canal.
8. Hernia peritonealis congenita: Congenital herniæ of the abdomen are characterized by dystocia of the abdominal viscera. They originate in the bulging of a less resistant portion of the peritoneum, which forms a hole or fissure in the abdominal wall. External and internal abdominal herniæ are to be differentiated. The former are visible from without, and resultant from outward bulging of the abdominal wall. The latter are not perceptible externally.

External abdominal herniæ are:

H. inguinalis interna, media, externa.

H. cruralis, ischiadica, perinealis, vaginalis, foraminis ovalis, umbilicalis, and abdominalis.

Internal abdominal herniæ are:

H. diaphragmatica, retroperitonealis, mesenterialis.

The majority of these are acquired. Congenital varieties are:

H. inguinalis externa (outward from the arteria epigastrica, following the spermatic cord).

H. umbilicalis: In the fœtus a loop of ileum lies within the navel opening.

C. Atresiæ: Result from failure of canalization of solid areas of cells, destined to become hollowed out, to form sacs and tubes.

Atresia of pylorus, intestines, ureters, urethra, Fallopian tubes, uterus, vagina, hymen.

Atresia through failure of the skin to bulge toward, and open into, perfectly formed canals.

Atresia oris, ani (usually associated with atresia of vagina, urethra, or seminal vesicles).

Atresia through closure of orifices: Vulva, nose, ear; of the vagina and hymen, either total or partial absence of the former from obliteration of the Müllerian ducts. Occasionally there is an imperforate diaphragm immediately behind the hymen.

D. Various other embryonic conditions, without corresponding external evidence of the anomaly:

1. Diverticula: Of the intestines are congenital widenings or bulgings of the gut; remains of the ductus omphalomesentericus, from the time of communication of the intestines with the umbilical bladder (allantois). Meckel's diverticulum lies in the inferior segment of the ileum, on the convex side, opposite the mesentery, about one metre from the Bauhinian valve. It is occasionally connected with the navel by the obliterated ductus omphalo-mesentericus.

2. Cryptorchismus: Is the fœtal condition. Dystocia of one or both testicles, usually one, the organ remaining in the abdominal cavity. Descent of testes begins about the third month, these organs entering the processus vaginalis during the seventh month. This anomaly is usually associated with microschismus.

3. Congenital luxations: Slipping of the head of the joint out its socket, from arrested development of the latter.

4. Club-foot: Pes varus, equino-varus, flat-foot, pes valgus, planus, equinus, also the combinations equino-varus and equino-valgus, pes calcaneum, also talipes-manus—club-hand.

In pes varus the outer edge of the foot is turned backward, the sole inward; in valgus the inner edge of the foot turns under, the sole points backward, the back forward; in calcaneus the heel looks backward, the sole forward. The fœtal placing of the feet corresponds nearly with pes varus; this position is readily observed in the new-born.

Persistence of a fœtal condition, arrest of, or overdevelopment, and pressure in utero, also muscular contracture of centric origin, are causes of these anomalies. Talipo-manus is occasioned by rudimentary development of the radius.

Monstra Per Excessum.

Malformations characterized by over-large, over-heavy, and supernumerary development.

I. Over-large development:
1. Giants, macrosomia: Apparent before birth, or commencing immediately after. Affects in the main the bony skeleton and muscular system. Sexual function is very often suppressed.
2. Abnormally large single parts:
Acromegalie (Marie): Enlargement of the pointed parts of the human body, hands, feet, nose, lips, chin, tongue, later the lower extremity; the distal portion of the forearm, lower jaw. The hypertrophy begins in youth or middle life, affects the bones and soft parts, and is always associated with muscular weakness, sensory disturbances, cephalalgia, and loss of memory, also dimness of vision and anæmia. According to Friedreich and Erb, this lesion is seen in several members of the same family.
Macrocephalus; hydrocephalus (apparent cerebral hypertrophy, actual atrophy); macroglossia; macrodactylia; dermatocele adnata (sac-like, fold-forming hyperplasia of skin); excessive size of thyroid, thymus (asthma thymicum), of the ovaries, omentum, mesentery (occasions sometimes twisting and incarceration), of the intestines, ureters, clitoris, penis, uvula.
3. Abnormal development of hair, and pigment (hirsutio adnata, hypertrichiasis).

II. Supernumerary formation:
A. Monstra duplicia, twin formation; general or partial duplication of the body. Either both twins are equally developed, or one is stunted and is parasitic to the other, more or less normally developed autosite, from which it is nourished.
α. Duplication of upper portion of body: Terata anadidyma.
1. Diprosopus: Double face, one body, two fused, incomplete heads (brain absent).
2. Dicephalus: Double head; one body, two heads.
3. Ischiopagus: Two upper bodies, a common pelvis, two or four lower extremities. (Fig. 262.)
4. Pyopagus: Two nearly separate bodies; sacrum, coccyx, rectum, and occasionally the vagina single.
β. Duplication of lower portion of body: Terata catadidyma.
1. Dipygus: Double body, one head.
2. Syncephalus (Janiceps): Two individuals fused together by head and hips.
3. Craniopagus: Two bodies fused on heads, and often shoulders.
γ. Duplication of upper and lower ends of bodies: Terata anacatadidyma.
1. Prosopothoracopagus: Skull cavities separated, under jaws developed, breast and neck fused.
2. Thoracopagus: Fusion of thoraces of two otherwise fully separate individuals (Siamese twins).

3. Epignathus: Prosopothoracopagus parasiticus: Fœtus in fœtu. The parasite is associated with the mouth of the autosite, usually the hard palate, and projects from the mouth.
4. Epigastrius: Thoracopus parasiticus: Fœtus in fœtu. Parasite attached from ensiform to navel of autosite.
5. Engastrius Abdominal inclusion of the parasite.
6. Rachipagus: Connection of two individuals at only one point on the vertebral columns; head, neck, a part of thorax, and lower extremities duplicated.

Fig. 262.

Ischiopagus tetrapus.

Mother, a full-blooded Indian, delivered by Dr. Felipe Martinez, San Francisco, Cal.

B. Monstra triplicia: Triple monsters; are exceedingly rare.
C. Supernumerary extremities:
   1. Polymelia: The number of entire or half extremities is increased.
   2. Polydactylie: The number of fingers or toes is increased.
D. Supernumerary organs. Practically all the separate organs may be increased in number.

Monstra Per Fabricam Alienam.

Anomalous position of parts or organs:
1. Situs transversus, inversio viscerum. Rare. Consists in complete transposition of otherwise healthy organs.
2. Dystopiæ of separate organs.
   Heart: Dextrocardia, ectopia cordis, in thoracic fissure.
   Bladder: Ectopia vesicæ urinariæ in fissura abdominalis.

Spleen
Stomach
Liver
Intestines
} In hernia diaphragmatica congenita, and fissura abdominalis.

Ovaries: In inguinal region, or labia majora; anomalous descent.
Left kidney: In or on edge of pelvic cavity, or in the fovea inguinalis.
Caput coli on left side.
Colon descendens, median through radix mesenterii.
Great hepatic lobe on the left.

CHAPTER XV.

PATHOLOGY OF THE FŒTUS.—Continued.

DISEASES OF THE FŒTUS.

Pathological conditions of the fœtus are classified as follows:

Hereditary disease;
Developmental errors;
Acquired disease;
    Nutritional errors; chemical, mechanical.
    Parasitismus;
Trauma from
    1. Local pressure effects;
    2. External violence.

Heredity. Recent advances in cytology have done much to throw light upon the subject of inheritance of disease, especially in the cytology and the *modus operandi* of the fertilization of the ovum. The classical researches of Flemming, van Beneden, Bovari, and O. and R. Hertwig have proven for all time that fertilization of the ovum consists essentially in the fusion of an exact quantity of nuclein or chromatin from the spermatozoid, with a similar quantity of the same substance in the ovum. The resulting segmentation of the ovum must produce cells whose constituent elements are a combination of chemical—vital—materials from both male and female progenitors. This mechanical theory abundantly explains the remarkable reproduction in the offspring of striking characteristics of either or both parents.

In the light of present knowledge it is impossible to formulate accurately the ultimate changes of a pathological nature occurring in those morphologic elements whose union is to produce a new entity; it can merely be assumed that they are essentially chemical—vital.

It must be that if the reproductive elements of either or both parents be impaired or altered in their nature, the change will inhere in the fœtus, and will be more or less evident, depending upon the condition of the other parent and his or her power to offset the deficiency. This theory of heredity holds equally for disease as for personal characteristics. The question thus arises, can such diseases as tuberculosis and syphilis be properly hereditary? Assuming both to be of parasitic origin, they cannot, in view of what has just been stated. Any heredity in these diseases must consist in regressive changes in the reproductive elements of one or both individuals, whereby the offspring is deprived of the power to resist invasion of the parasite, and offers a suitable soil for its propagation. The frequent skipping of a generation in tubercular families supports this view, as it goes to show that in the union of a tuberculously inclined individual with a perfectly healthy one, the peculiar lack in the reproductive elements of the one is counterbalanced by the normal elements in the other, to the extent of producing immunity in the *immediate* offspring.

In general, it may be said that heredity in disease consists in alteration

of quality, quantity, or both, of the original elements of fertilization; which alteration persists in the fertilized ovum, and tends to limit its normal development, and inaugurates pathological processes in the fœtus. It cannot at present, however, be denied that these changes may be characteristic of certain diseases, such as tuberculosis, syphilis, and alcoholism.

Fœtal Infection. It is proved that the fœtus in utero may suffer infection. The infection may originate from the mother, father, or both, and may be simple or mixed. Its origin may also be external, in the sense that the secretions of the genito-urinary canal of an otherwise healthy mother may become contaminated with septic organisms from douche tubes, etc., which invade the fœtus through the liquor amnii (Menge and Krönig).

Fœtal infection is acute or chronic. Of the acute processes, scarlatina, measles, smallpox, recurrent fever, and erysipelas are recorded, together with septic and pyæmic infections, where pathogenic organisms were recovered from the organs and tissues of the fœtus. Death and expulsion of the fœtus are usual in these cases.

Of the chronic infectious processes tuberculosis and syphilis are the chief. Malarial lesions of organs have been described without discovery of the plasmodium. Fœtal infection occurs through the utero-placental tissues, the cord, and the liquor amnii. Normally the latter has strong germicidal properties, which may, however, be destroyed.

Any area of the fœtal body may become infected. The determining factors are: the primary source of the infection, the resistance of different tissues, the nature of the infecting organism. The organic lesions will correspond with the pathogenesis of the infecting germ. Erysipelas, multiple abscess, and gonorrhœal ophthalmia are examples of acute parasitic infections. Tuberculosis and probably syphilis are examples of chronic infection.

Inflammation. Acute inflammatory processes are infectious in their nature. They are important from their tendency (1) to destroy important structures, as the eye in gonorrhœa; (2) to limit development, as in hare-lip consequent upon inflammatory adhesion of the amnion to the fœtal face; (3) to produce death of the fœtus, as in erysipelas. Of the chronic inflammatory processes tuberculosis and syphilis are most prominent and best understood. Congenital hydrocephalus is a consequence of chronic meningeal inflammation.

Hemorrhage. Prenatal hæmophilia is recorded. Aside from the hæmophilic diathesis, hemorrhage will result from the septic condition and trauma.

In sepsis the hemorrhages are usually petechial, and may be widely distributed. Very valuable evidence of the existence of sepsis lies in the finding of numerous very small petechiæ in the subserous tissues. Small hemorrhages may also be caused by cardio-vascular disease or anomaly.

Traumatism will produce large hemorrhages into the cavities of the brain, thorax, and abdomen.

Cephalhæmatoma results from pressure effects.

A. Jacobi asserts that small cerebral hemorrhages may occur in the fœtus, which, primarily unnoticed, ultimately produce epilepsy.

The writer has autopsied several cases of fatal cerebral hemorrhage in stillbirths, or death a few hours post partum, occurring in Dr. Jewett's

service at the Long Island College Hospital, which originated from a cardiac anomaly described below.

Malnutrition. This condition in the fœtus may be due to heredity (*vide supra*), or to disease of the utero-placental tissues or the cord. It may result from an abnormally large quantity of amniotic fluid or the reverse of this, also from imperfect development of an organic system, as microcephalus, general vascular hypoplasia, or imperfect elimination from renal lesions in the fœtus.

Specific diseases, particularly tuberculosis and syphilis, will cause profound fœtal malnutrition, resulting often in death. In marked cases the fœtus presents the general appearances of atrophy, the face looks old, and the skin is loose.

Fœtal Death occurs during any period of gestation. Very soon after conception it will be followed by total absorption of the products. Later it will give rise to mole. In the later months of pregnancy the dead fœtus will undergo maceration, putrefaction—which may involve the mother in sepsis—mummification, or calcification. The dead fœtus may be retained in the uterus for years. Dr. Lusk reported a case in which a normal labor was followed fourteen years later by the removal of a calcified fœtus. Retention of the products of conception *in utero* may give rise to hyperplasia and metastasis of chorionic elements, which thus form a neoplasm of highly malignant type. The lung is the most frequent seat of these decidual invasions. The neoplasm is called a deciduoma.

Fœtal death is caused by hereditary disease, acute infectious diseases, fœtal tuberculosis, syphilis, and malnutrition. It is also caused by utero-placental disease, by twisting and knotting of the cord, by hyper- and oligohydramnios, and by trauma.

Diagnosis of Death of the Fœtus. The diagnosis is difficult in the early months of gestation. The intra-uterine temperature of the mother is always higher than the vaginal while the fœtus is alive. An equal or lower temperature in a uterus containing the products of conception is probable evidence of fœtal death. On bimanual examination the uterus presents a boggy feel. Pelvic tenesmus is usually present in some degree.

The death of the fœtus can, as a rule, easily be determined when it has occurred after the period when fœtal movements are perceptible. The most reliable signs are the persistent absence of fœtal heart-sounds and of fœtal movements. The abdomen ceases to enlarge; the breasts become flaccid and diminish in size.

A fetid discharge from the vagina containing exfoliated epidermis is a certain indication of the presence of a dead fœtus. Should the fœtal head present at the pelvic inlet the cranium is found to be soft, and the cranial bones loose and movable, overlapping one another. The lips of the dead fœtus in a face presentation are flabby and motionless. No *caput succedaneum* can form during delivery, as there is no fœtal circulation to make it possible. Large quantities of meconium may be discharged, though the breech does not present. Yet this frequently occurs during the birth of a living child. Should the breech present, the examining finger will discover that the anal sphincter does not contract. Should the umbilical cord prolapse, it will be found flaccid and pulseless.

Infection of the mother from the dead fœtus in utero is extremely apt to occur, and its presence is indicated by depression, furred tongue, chilliness, fever, a pale and sallow color.

Errors of Development. Minor malformations, as hare-lip, supernumerary fingers, etc., are *Anomalies;* major malformations, as anencephalus, involving a considerable portion of the fœtus, are *Monstrosities.* Up to the time of Lemerey, Winslow, and A. v. Haller, monsters were regarded as wonders of evil omen.

Winslow and Haller regarded developmental errors as primary anomalies of the seed, present in it before fertilization; while Lemerey regarded them as due to interference with the processes of embryonic development.

As embryology became better known, J. F. Merckel and Geoffroy-Saint-Hilaire, father and son, treated the whole subject of teratology more thoroughly, and called attention to the relationship between arrest of normal development and persistence of the fœtus in a certain stage of development.

Förster was the first to collect and classify the literature on this subject; and, following him, Ahlfeld rearranged and extended it in a series of plates. (Thoma.)

Many interesting experiments have been made by such investigators as Geoffroy-Saint-Hilaire, Panum, Dareste, L. Gerlach, the brothers Hertwig, Roux, and others, with the result of proving that anomalies in embryonic development may be induced by mechanical means, such as separation of the elements of the segmenting ovum and axial change of its position during segmentation. These facts show the influence of environment upon fœtal development. Thoma, of Dorpat, draws attention to the fact that twins occurring from a single ovum develop circulatory disturbances in the nature of venous obstruction, with hepatic and other organic congestions due to anastomosis of the vascular systems of both individuals. Others have produced twins in the ova of *rana* by permanently inverting the primitive streak.

Notwithstanding all the brilliant work in this direction, we still know but little regarding the etiology of anomalous development. It is pretty clear that heredity, malposition of the blastoderm, intoxications and infections of the fœtus in utero, all play a part in the arrest of development, as well as oligohydramnios and trauma. (Schwalbe.)

As Thoma well puts it, fœtal disease *per se* is also significant in the production of anomalies: as increase of amniotic fluid, œdema of the embryonic tissues, organized adhesions between the fœtal tissues, and between these tissues and the amnion, and even isolation of areas of embryonic tissue, *e. g.*, dermoid cyst.

The same author also justly remarks that aside from gross errors in development, giving rise to extensive deformity, it is very important to remember that anomalies may obtain in single organs, which in time will produce secondary disease. Many aplasiæ will make life impossible to the child after birth; others will handicap it, and still others will constantly menace its existence. Practically those anomalies which tend to limit the possibilities of the child after birth are of greater importance to it; while monstrosities are of greater importance to the mother in the often grave complications they occasion during parturition.

Systematic Organic Lesions. There is not space in an article like this for a detailed description of all the lesions of the fœtal organs. In general, it may be said that the fundamental principles underlying these lesions are identical with those governing lesions in the adult, the one difference being rather of result—*i. e.*, arrest or alteration of develop-

ment in many instances in the fœtus. In describing some of the more important organic diseases, only such minor anomalies will be considered as tend to induce other pathological conditions.

Heart. Endocarditis is almost always in the right heart; is rarely acute, usually chronic, and due to syphilis.

Myocarditis is acute (from infection, Menge and Krönig), or chronic, and due to syphilis. In the latter case it is interstitial.

Endocarditis, with anomalous or incompetent valves, may produce a vicious circulation, and chronic venous hyperæmia; cases are reported in which typical nutmeg-liver and renal cyanosis complicated this lesion. Hemorrhage, marked or slight, may also be caused by it, and may involve any organ, notably the brain and lungs. Through the courtesy of Dr. Jewett, the writer has been able to autopsy several stillbirths and infants dying a few hours after birth in the maternity wards of the Long Island College Hospital, in which it was revealed that the pulmonary artery was immediately confluent with the thoracic aorta (through a large and persistent ductus arteriosus?), with extremely small branches running to the lungs. The right ventricle was hypertrophic. Aside from a few petechiæ in the subserous tissues generally, all of the cases showed very considerable hemorrhage at the base of the brain and around the medulla and pons. In all the parturition was normal, with not the slightest evidence of sepsis. In some of the cases there was pulmonary hemorrhagic infarct. In these cases, if the ductus arteriosus be regarded as the source of confluence between the pulmonary artery and the thoracic aorta, its structure was unusually thick, and in every way similar to the other portions of the vascular channel at this point. The writer believes that this may be a more common condition than is generally supposed.

According to Orth, who recites a very remarkable instance, hypoplasia cordis, with general vascular hypoplasia, is a very important fœtal condition, bearing direct relation to chlorosis in the young. His patient, a girl in her teens, died with marked chlorosis, and the autopsy revealed an infantile heart with an aorta that scarcely admitted an ordinary lead-pencil within it. It is probable that this condition may cause fœtal malnutrition not infrequently.

Tachycardia and arrhythmia are caused by nervous anomaly, general cardiac insufficiency, systemic fœtal infection, uterine pressure, and fœtal debility.

Tuberculosis is rare, and always discrete.

Bloodvessels. Anomalies of the vascular distribution are directly responsible for lack in development of entire parts, as, *e. g.*, a cerebral hemisphere.

Hemorrhage is by rhexis from cardiac lesion, or trauma, pressure in utero, efforts to respire before or during parturition, and hæmophilia, and by diapedesis in sepsis, icterus neonatorum, and probably hæmophilia. The hemorrhage of sepsis is very important, as it affords a point in diagnosis of the condition. The hemorrhage is always multiple and petechial, or at least small, and most conspicuous in the subcutaneous and subserous tissues.

Vasculitis. Acute vascular inflammation may supervene in the fœtal bloodvessels, and involve the adventitia or intima, or be diffuse; but the

most important inflammatory changes are chronic, and due to syphilis. Here there is active, small round-cell infiltration, with hyperplasia of *connective tissue*. Either the outer or inner, or both, coats are involved; and the lumina of the vessels may be diminished and eccentric. It cannot be doubted that such chronic vascular inflammations may arrest development, and, by inhibiting osmosis, produce profound nutrition disturbances.

Finally, microscopic examination of the tissues of fœtuses suspected to have died of infection has yielded positive results to a number of investigators. The writer, through the courtesy of Dr. Jewett, observed a multiple hepatic infection in an infant dying shortly after birth, where microtome sections revealed numerous foci of small round-cell infiltrations, and, amongst these cells and in the intralobular capillaries, micrococci. Menge and Krönig record a case in which septic anaërobes were found in the right heart of a stillbirth, where the liquor amnii had become infected.

Hyperplasiæ and aneurisms of the arterioles, capillaries, and venules are common, and form verrucose nævi and so-called birth marks.

Lymphatics. These structures are the seat of inflammation and are associated with the lesions of elephantiasis fœti. They are often angiomatous, and are common carriers of micro-organisms.

Lungs. Pulmonary œdema and hemorrhage occur as results of cerebral and cardio-vascular lesions, pressure effects in parturition, trauma, and sepsis. Hæmothorax from trauma is recorded. Atelectasis is normal until birth; it persists after birth from prenatal centric lesions and defects, or obstruction of the respiratory tract with inhaled mucus. It is partial or total.

Disseminated pneumonia is frequent in fœtal infection.

Syphilis gives rise to "white pneumonia" (Osler) and interstitial and vascular hyperplasia.

The writer has seen undoubted septic pneumonia in several cases of stillbirth in puerperal sepsis. Cross section of these lungs revealed characteristic areas of infiltration, which microscopic examination proved to be foci of small round cells, whose centres were in coagulation necrosis. Pleuritis has been recorded.

Spleen. Aside from anomalies, this organ will show the characteristic changes of sepsis, and, it is claimed, of malaria.

Primæ Viæ. Acute inflammatory lesions may obtain from infection. Menge and Krönig find evidence of it in cases where infection from the amniotic fluid apparently started in the stomach and intestines. Tuberculosis and syphilis occur in the stomach and intestines, and the mesenteric and retroperitoneal glands.

Of the anomalies, one or two are liable to produce trouble later in life. The writer has autopsied three cases of fatal perforative appendicitis where *situs transversus* was found. The caput coli in one case was literally transposed; in the other two it was displaced, and closely adherent to the sigmoid flexure. Diverticulæ are seen in any part of the canal, and may be sufficiently large to produce serious trouble. The stomach may be nearly inverted, and the cardia brought lower than the pylorus; or it may assume a vertical position. Gastric hypoplasia may be marked.

Atresia ani and recti may be of sufficient degree to prove fatal, or may be amenable to operation.

Liver. Reveals characteristic structural changes incident to cardio-vascular lesions and the parenchymatous changes of septic infection. It may be the primary focus of infection in the fœtus, the source of which is the cord or the liquor amnii. (Menge and Krönig.)

Icterus neonatorum will result from such infections, and may be complicated with fatal hemorrhage.

The writer has seen, and Menge and Krönig report, cases in which microtome sections revealed foci of small round cells, micrococci in the writer's case, and a short bacillus in those of Menge and Krönig.

Kidneys. Aside from their interest merely as curiosities, the renal anomalies are very important from their relative frequency and the bearing they have on surgery. A single kidney may be developed, or the two may fuse to form a horseshoe, or both may locate in the pelvis. One or both organs may be destroyed by hydronephrosis due to atresia of the genito-urinary canal at some point.

All of the changes due to renal cyanosis may be present as results of cardio-vascular lesions. These organs also show the general changes of infection; and localized areas of infection have been found, especially in the Malpighian pyramids (Menge and Krönig).

A very important congenital condition of the kidney, described by Orth, Rosenstein, and others, is multiple cystic degeneration of the cortical tubules. According to Rosenstein the crypts may be so numerous as to leave but little functionating tissue. The cysts never attain a large size. The condition is often accompanied with renal hemorrhage, and is, unfortunately, usually bilateral. The writer has seen one such case which came to operation for renal hemorrhage and tumor. The right kidney was very large, weighing about three pounds, and studded with hundreds of cysts, which varied in size from a pullet's egg to that of a pin-head. In this case both organs were involved, and the patient died of uræmia. The etiology of these cystic kidneys is very obscure. Not infrequently an infant dies within a few days after birth, and the kidneys are found to contain uric-acid infarcts, which are located, as a rule, in the medullary portions of the collecting tubules. According to Ziegler these infarcts form after birth as a result of the inability of the renal parenchyma to sustain the increased work thrown upon it.

Genital Organs. Aside from anomalies, the organs of generation may be the seat of infection, which is acute or chronic, depending upon the nature of the infection.

Osseous System. Osteomalacia, premature ossification, general hyperplasia, and infections of various nature occur.

"Spontaneous fracture" has been recorded, and is regarded as due to uterine contractions and trauma.

Luxations of the joints are due to anomalous development or oligohydramnios.

Oligohydramnios is in causal relation with talipes or similar conditions.

Centric Talipes. Centric lesions will also produce them by causing muscular contracture.

Muscular System. Aside from anomalies of development, the muscles

are subject to the same changes occurring in other tissues due to general causes.

The Skin shows the characteristic lesions of acute specific diseases, such as scarlatina, smallpox, erysipelas, etc. Syphilitic and tubercular lesions have also been observed.

Œdema, ichthyosis, and many other lesions of the skin have been recorded; but, as yet, their pathology is entirely obscure.

CHAPTER XVI.

ABORTION AND PREMATURE LABOR.

Definition and Classification. The term *abortion* signifies the expulsion of the products of conception before the sixteenth week of gestation, at a time when the placenta is not yet fully formed, and hence when it cannot be expelled or expressed (Credé's method) in its entirety.

Premature labor is applied to the delivery of a fœtus at any period from the time after it has become viable to within a few weeks before the normal termination of pregnancy. It is made to cover the period from the twenty-eighth to the thirty-sixth or thirty-eighth week of gestation.

For the intervening period (from the sixteenth to the twenty-eighth week) not included by abortion and premature labor, the term "*miscarriage*" is generally employed. The use of the latter term, though sanctioned by time and habit, is not satisfactory, as admitted by many authors who have submitted to the custom. It would appear that the term "*immature labor*" would be more appropriate. The processes of expulsion at this period of gestation resemble in a measure those of labor at full term, and they may be looked upon as constituting a labor in miniature. But the fœtus, though it may be born alive, is so immature in its development that it cannot be reared—in other words, it is non-viable. Hence, the adjective "immature" would fitly denote at once the nature of the delivery and the condition of the fœtus.

Viability of Fœtus. Assigning the twenty-eighth week as the period of viability is somewhat arbitrary; for with the modern incubators and improved methods of feeding, fœtuses born at an earlier period of pregnancy have been known to live and thrive.

Ribemont-Dessaignes and Lepage[1] make the weight of the fœtus a criterion of its viability. They consider it non-viable if it weighs less than 1000 grammes, and viable if it weighs more than that. French authors make the following divisions: (1) *Ovular abortion*, that which takes place before the twentieth day. (2) *Embryonic abortion*, that which takes place from the twentieth to the eightieth day. (3) *Fœtal abortion*, that which takes place from the fourth to the seventh month. This division is confusing and has no practical value.

Abortion is artificial or spontaneous according as it is or is not evoked intentionally.

Artificial abortion is spoken of as *therapeutic* when it is done for justifiable cause, and *criminal* when it is done for improper or immoral reasons.

Frequency. It is generally stated that from 30 per cent. to 40 per cent. of all married women abort before they reach the age of thirty years. But it is next to impossible to ascertain reliable statistics on this point. Many women abort at an early period of pregnancy

[1] Ribemont-Dessaignes et Lepage. Précis d'Obstétrique. Paris, 1897.

without knowing it, thinking that the menses were merely delayed and then came on rather profusely. Again, other women conceal the fact from motives of delicacy. The estimates of authorities differ widely. According to some writers, abortion occurs once in five or six pregnancies. Hegar[1] estimates the frequency as once in eight pregnancies. M. Bossi[2] states that to every one hundred pregnancies at full term there are twenty-five abortions. A collection of recent statistics places the frequency of abortions at one in every five or six normal labors.

Whitehead,[3] whose statistics are universally quoted, states that thirty-seven out of every one hundred mothers abort before they reach the age of thirty years. His statistics, however, were based upon the lowest classes of Irish peasants, who were living in Manchester in great privation and amid most insanitary surroundings, and with whom very early marriages were the rule.

Time of Occurrence. Abortion occurs most frequently before the third month—that is, between the ninth and twelfth weeks of pregnancy. This is generally the case when it is due to diseases and malpositions of the uterus, as chronic endometritis and backward displacements. It is especially liable to take place at the menstrual dates. It is very probable that this greater frequency at the third month and in the beginning of the fourth month is due to the fact that at this time important changes are taking place in the attachment between the ovum and uterine wall. It is the period of the formation of the placenta. The chorionic villi situated on the periphery of the ovum undergo atrophy, while those situated in contact with the uterine wall (the decidua serotina) become hypertrophied.

The extent of surface by which the ovum is attached to the uterus is, therefore, decreased, though at the point where it still remains attached —the site of the future placenta—it strikes deeper roots into the uterine tissues. When syphilis is the cause the pregnancy is more likely to be interrupted at the sixth, seventh, or eighth month of gestation.

It is commonly believed that early, especially first, pregnancies have more frequently a premature termination than those which come after. Still the majority of authors agree that multiparæ are more prone to abortion than primiparæ. This is to be attributed to subinvolution and other uterine disorders which may follow in the wake of this puerperium. According to Whitehead the third and fourth pregnancies and one or two of the last, those, namely, which occur near the termination of the fruitful period, are most commonly unsuccessful. This is particularly interesting, inasmuch as Whitehead's observations relate to a class of people among whom the girls married at the early age of thirteen and fourteen years. This experience corresponds with that of the author with Russian Jews, who also are given to early marriages.

Etiology. It may be stated, as a general law with some exceptions, that all etiological factors act either by exciting uterine contractions directly, or indirectly by causing the death of the fœtus, which in turn is followed by uterine contractions. For practical purposes the causes of abortion may be divided into those acting through the father, those acting through the mother, and those affecting the ovum.

[1] Hegar. Monatsch. f. Geburtsh., Bd. xxxi. S. 34.
[2] M. Bossi. Annali di Osteticia et Ginecologia, No. 2, 1898.
[3] Whitehead. Abortion and Sterility, etc. London, 1847.

PATERNAL. By far the most important and frequent cause of abortion proceeding from the father is syphilis. It is frequently overlooked because the manifestations of the disease may no longer be present, or they may never have been so marked as to excite the attention either of the patient or his physician. Tuberculosis, lead-poisoning (C. Paul,[1] Rennert[2]), alcoholism, extreme youth, great old age, excessive venery, may all act as causative factors. Ribemont-Dessaignes and Lepage[3] relate an observation which would go to prove that excessive coition may be a cause of abortion. Of thirty cows that were served by the same bull within a short period, the fifteen that were served first went to full term, the last fifteen all aborted.

MATERNAL. (*a*) *Acute infectious diseases*, especially typhoid fever, influenza, smallpox, cholera, scarlatina, measles, pneumonia, and acute intermittent fever. It is stated that measles is less likely to cause abortion than the other acute exanthemata. The more severe the affection, and the higher the fever and the more continuous it is, the more likely is abortion to occur. The germs may act directly on the fœtus through the placental circulation, or the attendant high temperature may destroy the fœtus (M. Runge[4]), or placental hemorrhages may occur as a result of the pathological changes set up by the constitutional affection (Zweifel[5]). There are various forms of infection in which toxins have an especial fatal effect upon the fœtus.

(*b*) *Chronic infectious diseases:* tuberculosis, syphilis, and severe malarial poisoning (T. G. Thomas[6]). Of these, syphilis is again by far the most common cause. According to Roemheld,[7] 27 per cent. of all interrupted pregnancies are due to syphilis in the mother. According to D'Aulnay,[8] syphilis in the mother is more likely to interrupt the pregnancy between the six and seventh month, while syphilis in the father is more prone to do so between the third and fourth month.

(*c*) *Organic diseases:* cardiac affections, especially those of the left orifice (A. McDonald,[9] E. Leyden[10]); chronic nephritis, causing white infarcts of the placenta and premature separation of the placenta.

(*d*) *Constitutional affections:* diabetes mellitus, progressive pernicious anæmia, lead-poisoning (Benson-Baker,[11] Rennert[12]), acute anæmia following sudden great loss of blood.

(*e*) *Emotional disturbance:* sudden shock, severe fright, profound sorrow, etc., may at times bring about the interruption of pregnancy.

(*f*) *Traumatism:* this as a cause of abortion must always be accepted with considerable scepticism. In a healthy condition of the uterus and the ovum the pregnant woman may sustain the severest injury without aborting. On the other hand, when the utero-placental vessels are fragile, as they are in some constitutional diseases—*e. g.*, syphilis—a slight traumatism, such as is occasioned by a fit of coughing, straining

[1] C. Paul. Arch. gén. de Médecine, 1860.
[2] Rennert. Arch. f. Gyn., 1881.
[3] Ribemont-Dessaignes et Lepage. Précis d'Obstétrique. Paris, 1897.
[4] M. Runge. Volkmann's klin. Vorträge, No. 174, and Arch. f. Gyn., Bd. xii. S. 16.
[5] P. Zweifel. Lehrbuch der Geburtshülfe, Stuttgart, 1895.
[6] T. Gaillard Thomas. Abortion. 1890.
[7] L. Roemheld. Inaug. Diss. Mainz. 1895.
[8] D'Aulnay. Arch. de tocol et de Gyn., 1894, No. 12.
[9] A. McDonald. Obstetrical Journal of Great Britain, 1877.
[10] E. Leyden. Zeitsch. f. klin. Med., 1893.
[11] Benson-Baker. Obstet. Trans., London, 1867, vol. viii. p. 41.
[12] Rennert. Arch. f. Gyn., 1881.

at stool, retching and vomiting, may be attended by a hemorrhage between the placenta and the uterus, and consequent abortion. A severe blow on the abdomen after the third or fourth month, when the uterus has risen into the abdominal cavity, may act as an exciting cause, either by causing the death of the fœtus directly or by bringing about a separation of the placenta from the uterine wall. In these instances, as a rule, the symptoms of abortion follow immediately the receipt of the injury. The laity, however, are only too prone to ascribe the interruption of pregnancy to the most trifling accidents, such as a misstep or a simple fall.

Major operations (ovariotomy and even myomectomy) have been performed on pregnant women without any deleterious influence upon the course of gestation. Operations on the vulva, however, are said to be more dangerous in this regard (Schauta[1]). Yet the author once excised a very much hypertrophied hymen, necessitating extensive suturing of the resulting wound, in a young woman in the fourth month of pregnancy, and she went to full term.

Too frequent indulgence in sexual intercourse not only lessens the virility of the spermatozoa, as we have already seen, but acts also as a traumatism and brings about a hyperæmia of the uterus. Hence, abortion is common in newly married women during the first five or six weeks of married life.

Sea voyages, even in absence of storms, and high altitudes (Sancerotte and Jourdanet, quoted by Charpentier) are said occasionally to cause premature expulsion of the fœtus.

Drugs. Certain drugs—ergot, savine, quinine, salicylate of sodium (the author[2]), and a host of others—are supposed to possess the property of bringing on abortion. It is doubtful whether they can do this in a normal condition of the uterus. When a strong predisposition exists, however, quinine and salicylate of sodium should be administered with great caution.

Local Causes. Backward displacement of the uterus is a very common cause (58 per cent., Roemheld[3]), in which condition it may be due to the inability of the fundus to rise above the promontory, and then it usually takes place between the third and fourth month. The termination of pregnancy may, however, occur later, and then it is said to be due to the chronic endometritis and metritis that are usually associated with the malposition.

The other conditions of the uterus that may give rise to abortion are chronic metritis, chronic endometritis, laceration of the cervix, mutilation of the cervix through an unskilful amputation, adhesions of the uterus to the pelvic wall or to other adjacent structures, fibromyomata or malignant growths, immature and abnormal development of the uterus (uterus bicornis, pregnancy taking place in a rudimentary horn), neighboring tumors, and pelvic deformities, which may interfere with the growth of the uterus. Artificial forward fixation of the uterus, either to the vagina or to the abdomen, has been known occasionally to produce abortion from inability of the fundus to grow, owing to too

[1] Friedrich Schauta. Lehrbuch der Gesammten Gynäkologie, Leipzig und Wien, 1896.
[2] H. N. Vineberg. New York Med. Journ., vol. lix. p. 785.
[3] L. Roemheld. Inaug. Diss. Mainz, 1895.

firm union with the vaginal or the abdominal walls. Marked disease of the adnexa may interrupt the pregnancy.

Habitual Abortion: Lastly, there are some women who abort over and over again, and in whom the most thorough investigation fails to find a reasonable cause. To this condition the term "habitual abortion" is applied. To attribute the tendency to a hyperæsthetic condition of the uterine system of nerves (T. G. Thomas[1]) or to congestion of the uterus (Napier[2] and others) is merely begging the question. By many authors the term habitual abortion is used interchangeably with re-

FIG. 63

Aborted ovum. Deciduæ and ovum complete. *o. i.* corresponds to the decidua situated at the os internum; *t. t.*, to the decidua situated at the openings of the tubes.

peated abortions. This is misleading from an etiological standpoint, to say the least.

FŒTAL. Under this heading are included all the pathological changes that may affect the ovum and its envelopes. Here, again, syphilis plays an important *rôle* by producing changes in the ovum or in the placenta which lead to the death of the fœtus and to consequent abortion. It may kill the fœtus directly through causing marked pathological changes in important organs, and the membranes may remain unaffected (Zweifel[3]).

[1] T. Gaillard Thomas. Abortion. 1890.
[2] W. D. L. Napier. Trans. London Obstet. Society, 1890, p. 389.
[3] P. Zweifel. Lehrbuch der Geburtshülfe, Stuttgart, 1895.

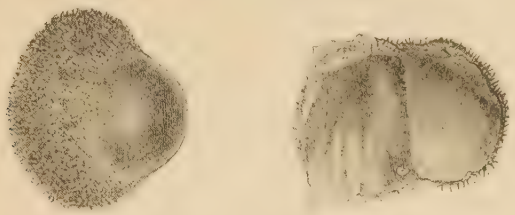
Syphilis may be transmitted directly from the father, and the fœtus die of it without infection of the mother ensuing. According to Napier,[1] when syphilis is the cause, the death of the fœtus occurs most frequently between the third and eighth months, very seldom before that time.

Various diseases of the decidua, placental apoplexy, and the different degenerations of the placenta, may bring about abortion by causing death of the fœtus. Polyhydramnios or oligohydramnios, by causing over-distention of the uterus, may also act as a causative factor, but in a different way, and may lead to premature expulsion of its contents. K. Hegar[2] in studying histologically 21 cases of abortion found in 11 cases what appeared to him an apparently primary disease of the fœtal envelopes. These changes were characterized by a disappearance or absence of the villi vessels and by an absence of the Langhan's cells.

Merttons[3] has described an obliterating endarteritis in the vessels of the chorionic villi, independent of syphilis, as a cause of the death of the fœtus.

Abnormal insertion of the placenta (placenta prævia) is very prone to

FIG. 264.



Closed. Open.

Ovum of the first month. The deciduæ have remained behind, the amnion has broken through the chorion; natural size. (WINCKEL.)

induce abortion, though it generally plays a more important *rôle* in the production of premature labor.

Pathology. To describe all the pathological changes of the membranes and ovum that are observed in abortion would lead us beyond our province. We will merely give those that we consider necessary for the elucidation of our subject.

In abortion there is invariably a rupture of the bloodvessels that connect the ovum and the uterine wall—in other words, of the utero-placental vessels. The effusion of blood usually takes place in the decidua vera, but not infrequently it forces its way between the decidua and chorion, also at times even breaking through the decidua and amnion and filling the amniotic cavity with blood. In abortions of more advanced pregnancy, after the formation of the placenta the blood is effused between the placenta and the uterine wall. In this manner the placenta is detached to a greater or less extent from its uterine insertion. In studying the pathological anatomy and mechanism of abortion we cannot do better than quote Dr. Berry Hart's[4] excellent description: Two forms must be considered: (1) Normal or complete; (2) abnormal or incomplete.

[1] W. D. L. Napier. Trans. London Obstet. Society, 1890, p. 389.
[2] Hegar. Beiträge, Bd. VI., H. 2, 1902.
[3] Merttons. Zeitschr. f. Geb. u. Gyn., 1894, XXX, 1–9.
[4] Dr. Berry Hart. Trans. Edinb. Obstet. Society, 1890–'91, p. 20.

Normal or Complete. There are two varieties depending upon the size of the ovum proper covered by reflexa. In the first variety, when the ovum is small, the decidua is separated in its whole extent and is expelled with the ovum. This is the exception.

In the second variety the decidua vera separates over the lower uterine segment, and the ovum proper is covered by reflexa driven down into the cervical canal, but remaining attached above by an apparent neck to the decidua of the retracting upper segment. The rest of the decidua is then separated and the whole expelled.

Abnormal or Incomplete. The following two varieties may occur:

1. The fœtus alone or the entire ovum with its chorion may be expelled through the reflexa. The decidua vera and reflexa are retained or expelled later.

2. The ovum covered by reflexa may be expelled, the apparent polypus neck having been snapped. The part thus expelled is often mistaken by the practitioner for the entire ovum. He sees an oval sac covered by decidua with amnion below this and containing liquor amnii and the fœtus. It is really only the ovum proper covered by reflexa, and the decidua vera and serotina in the shape of a sac are still *in utero*.

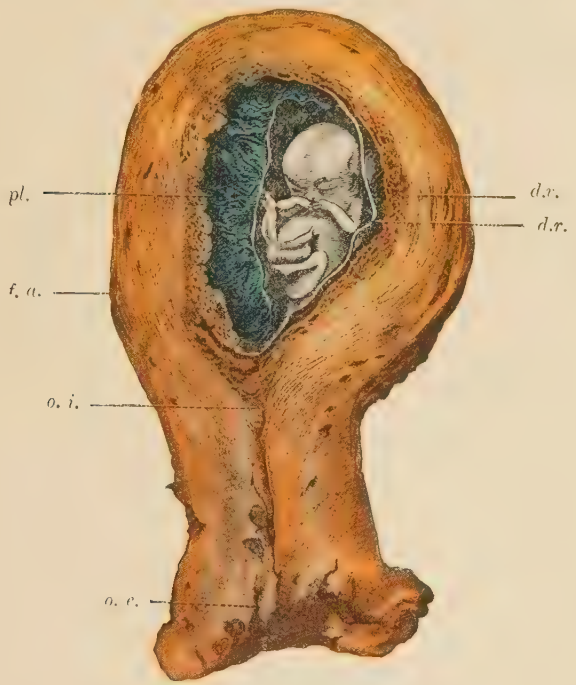
It happens occasionally that the extravasation of blood into the membranes takes place at different times, allowing the coagulation of the blood in strata, thus forming what is known as a *blood mole*. Should the process of abortion be slow in culminating, the coloring-matter of the blood becomes absorbed, the blood strata undergo partial organization, and there results what is known as a *fleshy mole*. This may form anew a connection with the uterine wall and be retained for an indefinite period. During this period it seldom gives rise to any disturbances, and the necrosis, as a rule, remains absent. These *moles* have generally a characteristic appearance, being covered with the decidua serotina and reflexa, and having remnants of the decidua vera hanging from them. On cutting them open the fœtus or ovum is found in the centre of a smooth-lined cavity—the amniotic. The fœtus is very small in comparison with the size of the expelled mass, and may be overlooked unless searched for with a magnifying glass.

In incomplete and neglected abortions the retained portions of decidua or of placenta may develop into a decidual or placental polypus in the following manner. The uterus, through contractions, endeavors to expel its contents, the placental residua are thus loosened in some places and hemorrhage occurs. The blood is deposited upon the placental remains in layers, forming a smaller or larger polypoid mass, which acquires a new connection with the uterine tissues. Decidual polypi are formed in exactly the same way (Winternitz[1]). These polypi may remain for weeks, or even for months, in the uterus without undergoing decomposition and without causing a fetid discharge or elevation of temperature. Winternitz[2] relates a case that came under his treatment six and one-half months after the abortion. The removed mass was free from any fetid odor. It is these formations that frequently are the cause of irregular hemorrhages, continuing for a long time after a supposed complete abortion.

[1] E. Winternitz. Sam. Zwanglos. Abhand. aus dem Gebiete der Frauenheilk., Bd. ii. Heft 4.
[2] Ibid. [3] A. J. C. Skene. Medical News, 1884.

The retained placental and decidual residua do not always behave in this benign manner. They may undergo decomposition, and if the drainage is not free, as is sometimes the case owing to the closure of the cervix, septic infection of a more or less serious nature may result. Still, as a rule, spontaneous abortion, especially at an early period, in the author's experience is very rarely attended with septic manifestations. When, therefore, he meets with a case attended with fever he suspects criminal interference, and in rigid cross-examination he almost invariably learns that the suspicions were correctly based.

FIG. 265.



Early pregnancy (two months). *o. e.*, os externum; *o. i.*, os internum; *f. a.*, upper limit of firm attachment of peritoneum; *pl.*, placenta; *d. v.*, decidua vera; *d. r.*, decidua reflexa. (HOFMEIER.)

The fœtus in cases of abortion is, as a rule, smaller than the period of pregnancy would indicate. This is particularly true of cases of fleshy mole, where the ovum dies at an early stage. It may then become entirely absorbed, or exist merely as a small white strand in the centre of the amniotic cavity. In other cases, after undergoing partial maceration in the liquor amnii, the fœtus may become mummified, and be thus expelled, or, again, putrefaction may set in and the putrid mass be expelled piecemeal.

Symptoms and Clinical Course. The symptoms of abortion vary at different periods of pregnancy. In the first six or eight weeks, prodromal symptoms are rare. The woman has not yet, as a rule, experienced any of the symptoms of pregnancy. The abortion has all the characters of a retarded and profuse menstruation, which the patient

often thinks it is. She loses considerable blood, and frequently passes large clots. Her suffering generally is not great—not more severe than that which ordinarily accompanies menstruation. Skene[1] speaks of some cases in which the hemorrhage takes place only at night when the patient is lying down. The explanation he offers is that the ovum dies and is not expelled, but acts as a valve at the os internum when the patient is in the erect position. When, however, "she lies down, it falls away from the os, and a hemorrhage takes place, the blood accumulating in the uterus when she is standing or walking about." At times there may be considerable uterine colic. If the woman recognizes the fact that she has been pregnant she will often state that "everything" has come away in the form of a large fleshy mass, which is usually nothing more than a large blood-clot partially organized. At this stage generally the ovum is rarely found; it passes off with one of the clots, or with the shreds of the decidua.

On bimanual examination the uterus is found enlarged, especially in its antero-posterior diameter, to about double the size of the non-pregnant uterus. The cervix may be quite closed or very slightly open.

In other cases the cervix will be found quite open, and the finger will detect just beyond the external os a smooth, globular, elastic mass, apparently attached to its interior. This, as we have already seen, is the ovum driven into the cervix, but arrested in its expulsion by the strong muscular fibres of the external os.

In a third class of cases the uterus will be found slightly, if any larger than normal. The continuance of the hemorrhage in these cases will furnish us the only evidence that all the products of conception have not yet been expelled. It is important to bear in mind that, though the uterus is not enlarged and the cervix is not patulous, the hemorrhage in all probability is due to retained decidua, for it is generally stated that retained decidua is always indicated by a patulous cervix. We have seen cases in which profuse hemorrhage continued for weeks with the local conditions just mentioned, and which were due to the presence of a fragment of decidua, perhaps not larger than the finger-nail. Dührssen,[2] who has had a very extensive experience as the assistant of Gusserow at the Charité in Berlin, says that "the retention of portions of the decidua vera is not the exception, but the rule."

In a very small percentage of cases where the ovum and its membrane are virtually expelled, either *en masse* or separately, the hemorrhage ceases in four or five days, and a local examination will detect merely a softened uterus, perhaps slightly enlarged.

After the second month of pregnancy premonitory signs are generally present. The patient will complain of bearing-down sensations in the lower part of the abdomen, and she will suffer more or less from a feeling of weight in the pelvis, from backache, from frequent micturition, and from a slight mucous or watery discharge. Pains resembling labor pains may precede any marked hemorrhage, though at times there may be considerable loss of blood before labor pains are experienced. The further advanced the pregnancy the more likely will it be that the labor pains will precede the hemorrhage, though the opposite may obtain at any period of prematurity.

[1] A. J. C. Skene. Medical News, 1884.
[2] Dührssen. Archiv f. Gyn., Bd. xxxi. Heft 2, S. 161.

On local examination the cervix may be found closed or partially open, according to the advance the efforts of the uterus have made to expel its contents. The uterus will be found to correspond in size with the given period of pregnancy, providing the fœtus has not yet been expelled. The latter fact is readily ascertained from the woman herself or any of the attendants, as the fœtus has now reached a stage of development which makes it easily recognizable by the laity.

The placenta may be expelled entire after the delivery of the fœtus, or it may come away piecemeal—a much more frequent occurrence. In the latter class of cases portions of the placenta may remain attached to the uterus for an indefinite period, as already stated, causing from time to time uterine hemorrhage. In cases of protracted abortion the woman shows signs of ill health. She grows more or less anæmic, has a somewhat haggard appearance, and feels too weak to carry on her usual duties. Of course, in cases of incomplete abortion, when the retained products undergo decomposition and putrefaction and septic infection occurs, the usual symptoms of sepsis manifest themselves, and the temperature usually runs high. It must be borne in mind, however, that we may have a severe form of sepsis with scarcely an elevation of temperature. These cases are generally very treacherous, as the poison acts chiefly on the heart.

Locally, as a result of infection, we may find an exudate in Douglas's cul-de-sac or at the base of one of the broad ligaments. In other cases there will be the local signs of pelvic peritonitis.

In abortions prior to the second month there is no true lochial discharge, but rather a sero-sanguineous flow lasting three or four days. In the later months the flow resembles more or less that following labor at full term, and the more advanced the pregnancy the closer the resemblance. After-pains are not common until after the fourth month. Before that period they are usually due to incomplete expulsion of the products of conception.

Involution takes place in less time than after labor at term. Subinvolution and the consequent metritis, however, are more common, owing to the neglect of the precautions usually observed after normal parturition.

Diagnosis. At first thought the diagnosis of abortion would seem to be an easy matter, but the practitioner will meet with no condition in his practice which at times will puzzle him to the same degree. In some cases the diagnosis is a simple affair. A woman who has always been regular passes one or two menstrual periods, then suddenly is seized with profuse hemorrhage, and on examination the cervix is found dilated and the finger comes into contact with a globular body—the ovum lying within it. Unfortunately, from a diagnostic point of view, such a combination of conditions is a rare exception. The first two conditions may be met with, but on examination the cervix will be found closed and the uterus but slightly enlarged. The questions confronting the examiner then would be: (1) Has the woman been pregnant? (2) Has she aborted? (3) Is the abortion complete or incomplete? Amenorrhœa in a married woman who has always been regular and who is not nursing is strong presumptive evidence in favor of pregnancy. Other signs should be looked for. A uterus perceptibly larger than the non-gravid

organ would confirm the diagnosis of abortion. The third question could be answered only by the presence or absence of hemorrhage, for with very few exceptions the hemorrhage will continue more or less irregularly so long as any portion or fragment of decidua or placenta is retained in the uterus. It is true that in some cases the presence of retained products within the uterus will be manifested by a patulous cervix, which will readily admit the index finger beyond the os internum, but the opposite condition, a closed cervix, obtains just as often.

The occurrence of hemorrhage in the pregnant state is always significant of threatened or actual abortion. But such hemorrhage, *more especially if it be slight*, may be due to other causes. A visual inspection of the cervix with the aid of a speculum ought to be made to ascertain whether the blood does not come from an erosion of the cervix, from carcinoma, or from a small cervical polypus. In some women there is a periodical flow for the first two or three months or more of pregnancy.

Ectopic gestation may be mistaken for abortion. At times nothing but a careful bimanual examination (under narcosis if necessary) will serve to differentiate the two conditions.

The points of distinction are: (1) The genital hemorrhage in ectopic gestation is more irregular and usually less profuse than in abortion. (2) The pain in ectopic gestation is generally more severe, and has the characteristics of severe colic more than of labor pains. (3) In ectopic gestation the patient is likely to suffer from syncopal attacks when rupture takes place, and at every recurrence of hemorrhage into the peritoneal cavity. (4) The mass formed by an ectopic sac is, as a rule, much more sensitive to pressure than an imprisoned gravid fundus uteri.

It occasionally happens that the gravid uterus enlarges irregularly on account of adhesions or of chronic metritis. As this condition is likely to lead to abortion sooner or later, it may give rise to the erroneous diagnosis of ectopic gestation (Vineberg[1]).

In very obscure cases, seeing that symptoms of abortion are present, there can be no objection to fully dilating the uterus under narcosis and exploring its cavity with the finger.

Prognosis. The menace to life in spontaneous abortion is very slight, but abortion is often the starting-point of serious trouble.

The *dangers* are:

(*a*) *Hemorrhage:* Although this is seldom so severe as to endanger life, yet the woman may be markedly weakened by the loss of blood, which may persist for weeks if not arrested by proper treatment. Occasionally, however, it may be so profuse as to cause death (Zweifel[2]).

(*b*) *Subinvolution:* This may result in chronic metritis and endometritis, which may lead to invalidism.

(*c*) *Septic infection:* This rarely occurs from retained products unless the woman has been examined by unclean hands, or had an unclean instrument passed into the uterine cavity. In the writer's experience, however, abortion in sharply retroflexed uteri is rather prone to be attended with septic infection. This, no doubt, is due to the circumstance that drainage is very markedly interfered with. Sepsis following abor-

[1] H. N. Vineberg. New York Med. Journ., vol. lix. p. 785.
[2] P. Zweifel. Lehrbuch der Geburtshülfe, Stuttgart, 1895.

tion is not, as a rule, so serious a condition as that following labor at full term. On promptly emptying the uterus the septic manifestations, as a general rule, readily subside. An exception, however, must be made in cases of sepsis following criminal abortion. Here the course of the affection may be virulent and rapidly fatal.

Treatment. *Prophylactic.* In order to succeed in the preventive treatment a very thorough investigation must be made of each case with a view to ascertaining the cause, and the treatment suitable for the condition found must be instituted.

If retroversion be present, a suitable pessary should be introduced after the uterus has first been replaced to its proper position. The case should be carefully watched, especially during the third month and the commencement of the fourth, when the fundus rises out of the pelvis.

After this the pessary may be removed. Chronic endometritis and laceration of the cervix call for appropriate treatment, which, of course, must be carried out before conception takes place. When uterine adhesions are the cause careful massage and stretching of the adhesions, followed by suitably placed tampons, may be attended with success.

The pelvic massage may be carried out even during pregnancy; the manipulations, of course, must be conducted with the greatest gentleness and caution.

If syphilis be suspected—and in cases of doubt as to causation it is always wise to suspect it—both parents should be subjected to a long-continued course of antisyphilitic treatment, and in the mother the treatment should be continued during the whole pregnancy.

Nervous diseases, such as chorea, etc., must be combated by the proper remedies.

In cases of habitual abortion, without any ascertainable cause, the woman should be enjoined to remain in bed during the time when the menses would normally recur. The rest in bed should be absolute, the patient not being allowed to get up to void urine or feces. Emotional excitement of all kinds should be prevented. Zweifel[1] states that he has met with success in some cases by entirely interdicting sexual intercourse during the whole pregnancy. Some authors speak favorably of the internal administration of potassium chlorate. The writer has met with apparent success with this form of treatment in a few cases. The salt is administered in five-grain doses, freely diluted, three times a day, and is to be given during the whole period of gestation. It is said to act by diminishing uterine irritation and congestion, and also by increasing the oxygen of the blood in the mother (Sir J. Y. Simpson[2]). Viburnum prunifolium has been highly lauded in habitual abortion by E. W. Jenks.[3] He advises from a half teaspoonful to a teaspoonful of the fluid extract four times a day, beginning at least two days before the menstrual date, and continuing it for two days longer than the periods usually last. Pregnant women in whom the habit of abortion exists should not be allowed to go on long railroad journeys, nor on a sea voyage. In these cases it is best that at least a year elapse after the last abortion before pregnancy again occurs. Physiological rest of the sexual organs for a long period occasionally has a happy effect.

[1] P. Zweifel. Lehrbuch der Geburtshülfe, Stuttgart, 1895.
[2] Sir J. Y. Simpson. Obstet. Memoirs, Edinburgh, 1865, vol. i. p. 460.
[3] E. W. Jenks. Trans. Amer. Gyn. Soc., vol. i. p. 130.

Treatment of Threatened Abortion. The abortion may be arrested so long as the death of the ovum has not occurred. But as it is next to impossible to determine this point, we are forced to act, in great measure, empirically. If the hemorrhage has been moderate, more particularly if the cervix has not yet dilated to any extent, we should direct our efforts to staying the threatening event.

It is rarely that we will meet with success after dilation of the cervix to the extent of admitting the index-finger has taken place. Still, even with this degree of cervical dilation, our efforts may occasionally be rewarded by seeing the process arrested, the cervix close again, and the gestation go on to full term.

The patient must be put to bed in a cool, darkened room and absolute rest enforced. She should not be allowed to sit up for any purpose whatsoever. The diet should be bland and cool. No one but the nurse and one other attendant should be admitted into the sick-room. The remedy which forms the sheet anchor in this class of cases is opium in some form. A good way of administering it is in the form of rectal suppositories, each containing one grain of the aqueous extract. One may be slipped into the rectum every four or six hours. If, when first seen, the patient is suffering severe pain it is good practice to administer at once a hypodermic injection of morphine (gr. one-sixth to one-fourth). Viburnum prunifolium in half-drachm or drachm doses every six or eight hours acts as a sedative to the uterus and constitutes a valuable adjunct to the opium treatment. If the hemorrhage is profuse the patient's hips should be elevated by a couple of pillows, and cold cloths cautiously applied to the vulva. The application of ice-cold cloths to the hypogastrium is not advisable, owing to the danger of exciting uterine contractions. The same objection applies to the employment of vaginal tampons or gauze packing.

The foregoing treatment should be continued until all hemorrhage and pain have entirely disappeared for at least two days. Great caution should be exercised after the cessation of the symptoms in allowing the patient to be up and about, or to resume her duties. On the reappearance of the slightest discharge of blood or on the return of the pains, the patient should be made to go back to bed at once.

When the threatened abortion is due to the incarceration of the fundus below the promontory, the patient should be placed in the knee-chest position and the cervix and vaginal vault exposed by lifting up the posterior vaginal wall with a good-sized Sims's speculum. The cervix is then caught with a tenaculum and gently drawn forward and downward while pressure is made against the fundus in the proper direction with a large wad of cotton held in an ordinary uterine dressing-forceps. In the majority of cases the manœuvre will succeed in releasing the fundus and making it clear the promontory. A couple of large, firm tampons should then be placed in the posterior vaginal fornix to maintain the fundus in the proper position. It may be necessary to repeat this treatment daily for several days, until all danger of the fundus falling back into the faulty position has disappeared. The patient need not necessarily stay in bed.

Treatment of Inevitable Abortion. When, in spite of the foregoing treatment, the symptoms persist and the abortion becomes inevitable, or when the case at the outset shows evidences that it would be useless

to attempt to arrest the process, our plan of treatment must be different. There is no further need of keeping the patient under so rigid restrictions.

The treatment of actual abortion still seems to be a disputed field. Some authorities (Dührssen,[1] Fehling[2]) strongly urge active interference at once. Others (Lusk, Winckel) favor an expectant plan of treatment, and would only interfere as necessity arises from hemorrhage or sepsis. It is the writer's custom to follow a course of action which lies about midway between these two apparent extremes.

For the purposes of treatment it is well to divide the cases into *early abortion* (before the tenth week) and *late abortion* (from the tenth to the sixteenth week).

When called to a case of *early abortion*, and there is evidence that the ovum has already escaped, and there is but a slight flow of blood which has lasted but a few days only, we can afford to wait a day or two longer to see whether the hemorrhage will entirely cease of itself. Of course, there must be an entire absence of febrile symptoms. The patient should be kept in bed, and the administration of ergot (ʒss t. i. d.) is advisable. While the total expulsion of the ovum and its membranes *en masse* is an exceptional occurrence, still in a fair proportion of the cases in which the ovum breaks through its envelopes and is expelled alone or with a portion of the decidua the remaining portions of the decidual residua are cast off either by uterine contractions or with the scant lochial secretions that follow.

In the same class of cases, if the hemorrhage be profuse, or even if it be scanty, but has continued now and then for several days, the proper course to pursue is to curette without further delay. In these cases, as a rule, the hemorrhage is due to retained decidua which is firmly adherent to the uterine tissue, and no amount of uterine excitants will stimulate the uterus to such a degree as to enable it to extrude the decidua. It is just in these early cases that it is often difficult to know whether the ovum has already been cast off or not. When in doubt in this regard it is good practice to decide in favor of curettage at once.

The operation when properly done—and every practitioner ought to know how to do it properly—is so free from danger and accomplishes the object in view so satisfactorily that the benefit of the doubt may be cast in its favor. The facts should always be plainly stated to the patient, and if she elects to wait to see what nature (perhaps with ergot) will accomplish, she must do so on her own responsibility. During the waiting period, if the hemorrhage be at all profuse, the vagina should be tightly packed with iodoform gauze, which may be left *in situ* for twenty-four or forty-eight hours. It must not be forgotten that all contact with the interior of the vagina must now be carried out under strict aseptic or antiseptic precautions.

In another class of cases, forming only a very small percentage, at the first examination the ovum is found enveloped in some of its membranes lying in the cervical canal.

In some of these cases the ovum is easily removed by hooking the finger above it and drawing it down ; in others again, the external os is

[1] Dührssen. Archiv f. Gyn., Bd. xiii. Heft 2, S. 161.
[2] Fehling. Archiv f. Gyn., Bd. xiii. S. 222.

so rigid and unyielding that its lips may have to be cut before the ovum can be extracted. An ordinary placental forceps will at times prove very serviceable in seizing the ovum and twisting it off as one would an ordinary polypus. In the majority of these cases any further interference will be unnecessary. But if the hemorrhage should not promptly cease after the above procedure the uterus should be subjected to a thorough curettage.

In a third class of cases there may be unmistakable evidence, in the circumstance that the uterus corresponds in size to the period of gestation, that the ovum and all its membranes are still within the uterine cavity. Two courses are offered, provided it has been concluded that the abortion is inevitable: (1) To anæsthetize the patient, forcibly dilate the uterus with branching dilators, and thoroughly empty the uterus, be it with the fingers alone or with the curette alone, or with a combination of both; and (2) to pack the cervix and vagina with iodoform gauze, and wait for twenty-four or forty-eight hours to see if nature will be able to complete the process. The author's custom is to adopt the first course, unless the patient strenuously objects to it. The objection that may be raised against this plan of treatment is that it usually necessitates reliance upon the curette alone, as it is not often that the cervix can be dilated to the extent that one or two fingers may be passed into the uterine cavity. Should any one, however, not have sufficient confidence in his skill to use the curette in this manner, the second course may be pursued in part. The packing can be made to serve the double purpose of arresting the hemorrhage and dilating the cervix. After the lapse of twenty-four or forty-eight hours the cervix will usually be found to have undergone sufficient dilation to admit one or two fingers, with which the greater part of the uterine contents may be removed. The gentle use of the curette will succeed in bringing away the remainder. The employment of any form of tents to dilate the cervix is unsafe and unreliable practice.

A great deal of discussion has taken place as to the relative merits of the finger and the curette for emptying the uterus in abortion. It really matters little which is used, so long as the products of conception are totally removed. In a great number of cases it is impossible to obtain such dilation of the cervix as to admit the introduction of one's finger. On the other hand, even when the finger can enter the uterine cavity it is not often possible by this means to bring away all the contents. In these cases it is the writer's practice to remove as much as possible with the finger, and then to supplement it with the use of the curette, employing the finger from time to time to ascertain if there is still anything left behind.

In *late abortions* the general line of treatment resembles more or less closely that just described. At this period, however, we do not meet with the same difficulty in determining in a given case whether or not the fœtus has been expelled. It is no longer possible for it to escape without exciting the notice of the patient or the attendants. If the fœtus be still within the uterus it is a good plan to pack the vagina with iodoform gauze, pushing as much of the gauze within the cervix as possible, even should the hemorrhage be not profuse. The cervical and vaginal packing has the effect of exciting uterine contractions, bringing

about cervical dilation, while at the same time it forms a safeguard against the occurrence of hemorrhage. At the end of twenty-four hours the packing should be removed, and if the cervix be found dilated the uterus should be emptied with the patient fully anæsthetized. In extracting the fœtus care should be taken not to tear the trunk away from the head, the delivery of which may occasion considerable difficulty. This accident, however, will happen at times, no matter how careful we may be. It is a good plan in these cases to depress the uterus with one hand above the symphysis, and thus fix the round ball-like body, while with the finger or fingers of the other hand in the uterus a hole is bored into the head, which thus being hooked into may be easily extracted. When it cannot be thus delivered it may be easily broken up with the fingers and removed piecemeal. In carrying out these manœuvres care ought to be exercised not to lacerate the soft uterine walls, an accident that need never occur, and one which the author has never met with, although he has resorted to this course on several occasions. The secundines in the majority of cases can next be removed with the fingers in the uterus, being aided by the other hand above the pubis, with which the uterus is depressed and held in a steady position. When the secundines cannot all be removed in this manner, the interior of the uterus may be gently scraped with a large partly sharp curette—Mundé's or Lusk's (H. J. Garrigues[1]).

If it be found that the fœtus has already been delivered, but that the secundines are still retained, the latter should be removed at once in the manner just described in the event of hemorrhage or sepsis. In the absence of these one may wait a reasonable time, even as long as twenty-four hours, to see if nature will not complete the process. If the cervix be not sufficiently dilated, forcible dilatation should be practised, either with the finger or a steel divulsor.

In all cases after emptying the uterus its cavity should be thoroughly irrigated with plain sterilized water, lysol (1 per cent.), carbolic acid (2 per cent.), creolin (½ per cent.), or corrosive sublimate (1 to 2000 or 3000). When using the latter agent an irrigation with sterilized water should follow. The toxic effects of corrosive sublimate solutions are due not so much to absorption during the irrigation as to the fact that a certain amount of fluid always remains behind in the uterus and is in part absorbed before it can drain away.

Septic infection: At all periods and in every stage of abortion where there are any indications of sepsis, as manifested by elevation of temperature and rapidity of the pulse, or by a too rapid pulse, the temperature remaining normal or only slightly above it, active interference is called for at once. A day's delay, or even one of several hours, may allow a mild sepsis to develop into one of a serious nature such as may be beyond our power to control. As a general rule, the sepsis that occurs in the course of an abortion is readily amenable to the proper treatment, which consists in emptying the uterus thoroughly, and following this up with irrigations along the lines already laid down. An exception to the above rule is the sepsis occasionally seen in criminal abortions, which may run as *foudroyante* a course as the severer sepsis following labor at full term.

[1] H. J. Garrigues. The Medical News, Nov. 6, 1897.

Should the symptoms of sepsis not subside completely under the foregoing plan of action, the case would have to be treated on general principles and these complications met as they arise. In some cases it may be found necessary to dilate the cervix from time to time so as to insure good drainage. Packing the uterine cavity in these cases is absolutely to be avoided, and even a strip of gauze in the cervix to favor drainage is, in our opinion, a snare and a delusion. There still seems to be a fear lurking in the minds of some distinguished authorities (Lusk,[1] Garrigues,[2] and others) that curetting a highly septic uterus will destroy the protective wall which nature forms, the so-called "granulation zone" of Bumm.[3] The fear is founded upon a supposed fact which does not in reality exist. The "granulation zone" was observed by Bumm only in the milder cases of sepsis, in the so-called cases of "putrid intoxication"; in the severe forms of infection no such protective zone was seen, but the microorganisms were found penetrating the whole thickness of the uterine wall and on the peritoneum. If Bumm's observations were to guide us in our clinical work we would refrain from curetting the *mild* cases of uterine sepsis, while in the severe forms they would constitute no contraindication, for we could not destroy that which did not exist. But, as a matter of fact, the cases in which a well-marked "granulation zone" was observed were the very cases which had been curetted, and which were promptly benefited by the curettage. If, therefore, there are evidences of retained products of conception there need be no fear of curetting the uterus though symptoms of sepsis be present.

The patient from the outset should receive the general treatment usually applied to septic conditions following parturition at term, and as this is fully described in another part of this treatise, it will be unnecessary to repeat it here.

Immature labor: The treatment of immature labor is the same as that for premature labor, which will receive attention later. There is probably a greater tendency for the placenta to be retained in the uterus than when pregnancy is interrupted at a more advanced period. If there be no hemorrhage, nor any elevation of temperature, and the pulse is normal, there is no harm in waiting twenty-four or forty-eight hours to see if the uterus will of itself be able to expel the placenta. But to tampon the uterus and vagina during this period, as recently recommended by Garrigues,[4] would seem to be an unsafe procedure and one likely to favor sepsis. If such a contingency arise in country practice much the safer plan is to remove the placenta manually at once should attempts to express it by Credé's method fail.

The patient might be seized with a dangerous hemorrhage in the physician's absence, which might prove disastrous before he could reach her. Beside, there is a prevalent prejudice among the laity that is not entirely unfounded against leaving the after-birth in the uterus for any length of time after the fœtus has been delivered.

[1] Wm. T. Lusk. The Amer. Journ. of Obstetrics, 1896, vol. xxxiii.
[2] H. J. Garrigues. The Medical News, Nov. 6, 1897.
[3] E. Bumm. Archiv f. Gyn., Bd. xl. Heft 3, S. 398.
[4] H. J. Garrigues. The Medical News, Nov. 6, 1897.

Curettage. The operation of curetting the uterus may now be described. The description may be premised by saying that the same care in asepsis and antisepsis ought to be exercised in regard to it as to that of any major operation. It is only by making this a routine in everyday practice that infection can be averted in cases which have not already been rendered septic. The operation should not be followed by rise of temperature in a clean case, and when it is, we must, as a rule, assume that we have introduced the pathogenic germs.

The patient should be placed upon a table in the lithotomy position. This can be attained by the various leg-holders in the market, or, in the absence of these, by twisting a sheet diagonally, tying one end around the thigh near the knee, making it pass over one shoulder and underneath the other, and tying the other end around the opposite thigh, both thighs being flexed upon the abdomen. The vulva and surrounding parts should be thoroughly scrubbed with an ordinary hand-brush and with warm water and green soap. Shaving off the hairs of the vulva may or may not be done. It is the writer's practice to do it. The hands should then again be washed before undertaking to scrub the vagina, which ought to be done thoroughly but not roughly. A gauze compress held in uterine forceps serves this purpose very well, aided from time to time with two fingers of one hand. There is nothing better to reach all the corners and crevices of the vagina than the fingers, or the half hand when there is a wide orifice. The vagina and vulva are then freely irrigated with sterilized water, which may be followed by an irrigation with some antiseptic solution. The legs should now be covered with sterilized cotton stockings or, what answers just as well, sterilized pillow-slips, and sterilized towels be placed upon the lower part of the abdomen, over the buttocks, and beneath the nates; in short, every part in the immediate vicinity of the operating field except the vaginal orifice should be covered with sterilized cloths. While this is being done by the nurse, the operator should again subject his hands to a thorough scrubbing and washing. A weight-speculum (Edebohls') retracts the posterior vaginal wall and exposes the cervix, which is seized with one or two volsellæ. No traction should be made with these, their purpose being merely to fix and steady the uterus. With one of the branching dilators the cervical canal is gradually dilated. Hegar's cervical bougies or Hanks' steel dilators may first be used, and the dilation increased by the branching instrument. In some cases the cervix is very rigid, and to overcome this considerable force will be required; in others, again, the tissues are very friable, and here the greatest caution must be exercised, or a serious tear extending into the uterus may be readily inflicted. After obtaining all the dilation possible within safe limits, an attempt may be made to introduce the index-finger of one hand. The finger may be able to locate the situation of the retained products, and perhaps remove them. In this procedure the instruments should be removed and the uterus depressed with the other hand above the symphysis.

In many cases it will be impossible to dilate the cervix so that the finger may be introduced, as has already been stated. In these the curette alone will have to serve our purpose, and the sharp instrument is the one we invariably employ. Very many object to the use of a sharp curette as being too dangerous, and recommend a dull one. It

seems to us that less harm is likely to be done with a sharp than with a dull instrument, for we can gauge the necessary force to employ more accurately with the former than with the latter. It must be admitted that the uterus may be perforated with either instrument, even in skilled hands, but ill results need not necessarily follow. When it is learned that the accident has occurred, the remainder of the uterus may still be curetted, care being taken to avoid the point of injury, and no irrigation should be employed. Should any inflammatory reaction follow, an ice-bag may be placed over the lower part of the abdomen and opium suppositories administered. There is no excuse for some of the serious accidents that are occasionally reported. They are not inherent in the operation, but are due to a combination of brute force and gross ignorance on the part of the operator.

The three accidents reported by M. D. Mann[1] were due not to the use of the curette, but to the branching dilator, which in two of the cases evidently perforated the uterus when being introduced, and the perforations were increased in size by introducing forceps which seized coils of intestine. In Mann's[2] own case the tear in the uterus was effected with Goodell's dilators. Still he thoroughly curetted the uterus after the accident, and the patient made a good recovery. Why these cases should be used as a warning against the use of the curette, as Mann seems to imply, it is difficult to understand.

Injury to the uterus in curetting is more frequently inflicted by pushing the curette through the uterine wall than in the act of scraping. By bimanual examination the size of the uterus, and consequently the depth of its cavity, can be fairly well estimated. By this means also the direction of the canal can be ascertained. In introducing the curette, therefore, one ought to know in which direction to carry it and when it may be expected to reach the fundus. No force whatever should be employed in this manœuvre.

Having passed the curette to the fundus the wall is scraped on withdrawing it, and one soon learns in which region of the uterus the retained products are situated. The curetting at this point may be done more vigorously, but a close watch must be kept upon the nature of the tissues removed. With a little experience one readily learns when the curette has reached the harder uterine tissue. In cases in which the uterus is very soft, the instrument, if a sharp one, need merely to be gently drawn over the surface. While the curette is being used, it is a good plan to apply one or two fingers of the other hand through the vaginal wall against that portion of the uterus which is being scraped internally. This steadies the wall of the uterus and aids us to gauge the force to employ. It is particularly in the cornua that decidual and placental residua are likely to be retained. These regions of the uterus, therefore, call for especial attention. When the operator feels satisfied that everything has been removed, the uterine cavity should be irrigated as stated above, but packing the uterus or the vagina with gauze ought to be avoided except in those instances in which uncontrollable hemorrhage follows the operation.

It is a good plan to administer ergot for the following four or five days or longer, in order to favor involution. The patient should be kept

[1] M. D. Mann. The Amer. Journ. of Obstetrics, 1895, vol. xxxi. p. 603. [2] Ibid.

in bed for six or seven days, at the end of which time the uterus should be examined bimanually to ascertain if involution has progressed satisfactorily.

Missed Abortion and Missed Labor.

Missed Abortion. It occasionally happens that the fœtus dies and the progress of gestation ceases, but the products remain within the uterus for weeks or even months. To this phenomenon the term "missed abortion" is applied; a similar condition occurring when pregnancy has arrived at full term is called "missed labor." These cases are also of interest from a medico-legal standpoint, as, for instance, when a woman has been separated from her husband for a longer period than would be indicated by the age of the expelled ovum.

Missed abortion must also imply a comparatively quiescent state of the uterus, in order to distinguish it from prolonged abortion (W. Japp Sinclair[1]).

As a rule, at the time of the death of the fœtus a slight hemorrhage occurs; but this may be absent, as it was in the three cases reported by Sinclair. It is seldom necessary to interfere manually in these cases. According to Sinclair,[2] "missed abortion" does not occur among young and presumably vigorous primiparæ. The writer's patient was young, but of rather delicate build, and had mitral stenosis. The same authority states that there is seldom a history of previous abortions or retentions in these cases; in our case there had been.

Missed Labor. In this condition there may or may not be some of the phenomena of ordinary labor at the time parturition should normally occur. If they do occur, the pains and the discharge are very slight, and soon cease.

The fate of the retained child varies very much. In some instances when the membranes are not broken and no atmospheric air enters the amniotic cavity, the fœtus may remain fresh for a long time; in others it becomes macerated and undergoes mummification. In other cases again, when atmospheric air does enter the cavity, putrefactive changes set in, giving rise to the condition known as *physometra*. Sometimes the soft parts of the fœtus disappear through liquefaction, and the bones are a long time in being discharged; sometimes they pass through the uterine walls and appear in the vagina, rectum, or bladder, or they set up in their passage an inflammatory process about the uterus, leading to a pelvic abscess.

It is generally recommended to wait a few weeks in cases of missed labor, in the hope that the uterine contents may come away of themselves without artificial interference. Should this plan be pursued the patient ought to be carefully watched, and on the slightest manifestations of fever or symptoms of sepsis the uterus should at once be emptied of its contents. One should always decide in favor of artificial interference as soon as there is positive evidence of the death of the fœtus. The woman is exposed to less risks by the adoption of this plan of procedure, carefully conducted, than she would be by carrying about a dead fœtus for an indefinite period.

[1] W. Japp Sinclair. Brit. Gyn. Journ., 1887–'88, p. 201. [2] Ibid.

In every case after the delivery of a dead fœtus, it is a good plan to follow the expulsion of the placenta and membranes with a copious intra-uterine douche of some mild antiseptic solution.

The administration of ergot for some days after the emptying of the uterus is particularly advisable, as the uterus in these cases has a tendency to inertia and retarded involution.

Premature Labor.

The factors already stated as being causative of abortion may likewise act at a later stage of gestation, and be the means of prematurely terminating the pregnancy.

The most common causes, however, are faulty insertion of the placenta, albuminuria, and syphilis.

In 357 cases analyzed by Vallais[1] faulty insertion of the placenta was present in 179 cases, albuminuria in 39 cases, and syphilis in 33 cases. In 82 cases no cause could be ascertained.

Treatment. When a woman is threatened with premature labor and the fœtus is still alive, one would naturally endeavor at first to avert it, unless there were marked albuminuria and threatening symptoms of an eclamptic seizure, or in the presence of a faulty insertion of the placenta (placenta prævia and placenta marginalis); in such contingencies one would, on the contrary, hasten the event. Opium must now be given with some caution, for fear of its unfavorable effect on the fœtus. A combination of potassium bromide and chloral hydrate (āā gr. xv.) acts well in these cases. Should one's efforts fail and the labor go on progressing, its management is precisely similar to that of labor at term, and hence does not call for special attention here.

[1] François Vallais. Thèse, Paris, 1893.

CHAPTER XVII.

ECTOPIC GESTATION.

Definition. When an impregnated ovum becomes fixed and begins to develop outside of the uterine cavity, ectopic gestation or extra-uterine pregnancy is established.

Varieties. The classification of ectopic gestation into tubal, ovarian, and abdominal, made by Bianchi in 1741, and simplified by Boehmer in 1752, remains practically unchanged, as far as the primary forms are concerned, unto this day. The terms *primary* and *secondary*, as applied to ectopic gestation, refer to the conditions before and after rupture or change of location of the ovum. As will hereafter be shown, rupture and change of location occur in the majority of cases, the anatomical relations of the ovum to its surroundings being thereby altered. Cases of primary ovarian and abdominal gestation are so rare and so difficult of absolute demonstration, that the general statement may be admitted that every ectopic pregnancy is primarily tubal.

Tubal pregnancies are classified according to the site of attachment of the ovum as (1) interstitial, the so-called tubo-uterine; (2) true tubal, isthmial, or ampullar, and (3) infundibular or tubo-ovarian.

1. **Interstitial Pregnancy** refers to that class of cases in which the ovum develops in that portion of the tube which passes through the wall of the uterus, or in a diverticulum from that part of the tube.

2. **True Tubal Pregnancy** is the variety in which the ovum develops in the free portion of the tube, without protrusion into either the uterine or the abdominal cavity. When it occurs in the inner portion of the tube, it is termed *isthmial*, and when in the outer, *ampullar*.

3. **Infundibular Pregnancy** includes the cases in which the ovum is lodged and developed in the infundibulum of the tube, and prevents closure of its abdominal ostium. The cases of this variety in which the ovum is attached to the ovary are ordinarily styled tubo-ovarian.

Ovarian and Abdominal Pregnancy are terms applied to those cases of extra-uterine pregnancy which are supposed to originate and develop in the ovary or in the abdominal cavity, no attachment having occurred to any portion of the tubal mucosa. Several cases have now been carefully examined and minutely described, practically proving the possibility of true ovarian pregnancy.

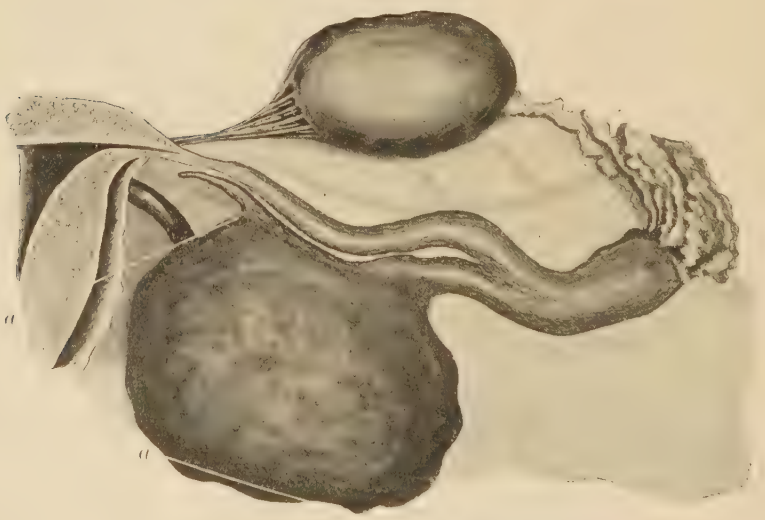
It is held by some of the best investigators in this field that the fertilized ovum can begin its development only in tissues derived from the Müllerian tract. Clarence Webster lays special stress upon this predisposition of Müllerian tissue as necessary to primary implantation in ectopic gestation of the ovarian type, and believes that decidual formation in abnormal locations always springs from detached portions of this tissue. If this view is accepted, the possibility of true primary

abdominal pregnancy must probably also be acknowledged, as detached portions of Müllerian tissue and supposed decidual cells have been demonstrated implanted in various intra-abdominal locations.

FIG. 266.

Ectopic gestation in blind accessory fimbriated extremity of right tube.

FIG. 267.



Left Fallopian tube with ectopic gestation in diverticulum.
a, a. Gestation sac communicating with diverticulum.

Anomalous Varieties. Ectopic pregnancy may occur in an accessory fimbriated extremity (see Fig. 266) or in a diverticulum from the Fallopian tube (see Fig. 267). Both of these varieties are, to all intents and purposes, tubal pregnancies.

Cornual Pregnancy occurs when the seat of gestation is in the undeveloped horn of a bicornate uterus. This anomaly is due to unequal devel-

FIG. 268.

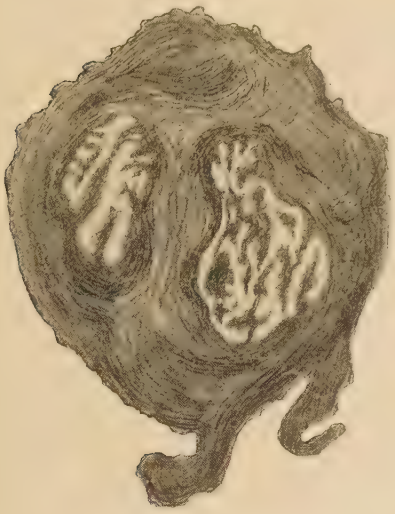


FIG. 269.

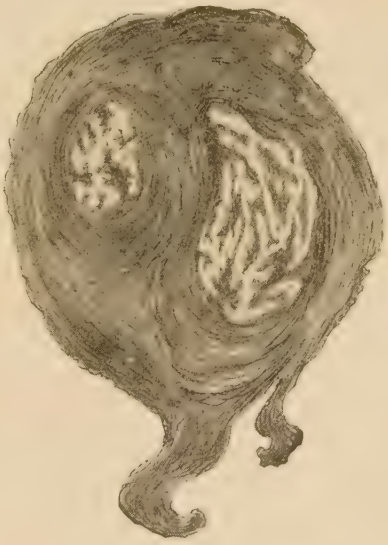


FIG. 270.

Sections made from case represented in Fig. 236 on each side and at extremity of diverticulum. They show distinctly the separate canals and the narrowing of the diverticulum as it approaches the uterus.

a, a. Lumen of main canal of Fallopian tube. *b, b.* Lumen of diverticulum.

opment or lack of proper union of the two Müllerian ducts. Although cornual pregnancy in its course and termination resembles extra-uterine

pregnancy, it cannot properly be classed as a variety of the latter, but is a true uterine pregnancy, which, by reason of the malformation of the organ, eventually becomes pedunculated and walled off from the main cavity. It is, however, surrounded by uterine mucosa, and the decidua is formed in the impregnated cornu.

Any attempt to classify the secondary forms of extra-uterine pregnancy leads to confusion. In this connection the term *secondary* means subsequent to rupture or displacement. When an ovum breaks through its outer investing structures without rupture of the sac, its development is not necessarily arrested, although its anatomical relations may be changed. They are usually called "abdominal," but it should be borne in mind that this term commonly refers to secondary implantation in the general cavity following rupture. These secondary forms are simply complications of the primary varieties before described, and are not deserving of separate classification. The various names applied to these forms are in such common use, however, that they can hardly be ignored. They will, therefore, be mentioned later.

Etiology. The point at which the spermatozoa meet and impregnate the human ovum is not definitely known. That the spermatozoa pass through the lumen of the Fallopian tube with ease is a fact, and it is very probable that in man, as in other mammalia in which this observation has actually been made, impregnation usually occurs in the fimbriæ of the tube.

FIG. 271.

Left Fallopian tube with diverticulum reconstructed.
a, a. Diverticulum.

The habitual ease with which spermatozoa pass from the orifice of the vagina through a virgin os uteri, oftentimes occluded by mucus, into the uterus, and the occasional cases in which, despite frequent disturbance, they travel from outside the vulva, through an almost imperforate hymen, up a vagina containing secretions destructive to their life, and finally pass uninjured into the uterus, make it reasonable to suppose that they may go with not less ease up the uterus into the Fallopian tube, and even into the abdominal cavity. There is no reason to believe that the ciliated epithelium of the tube, which assists the migration of the ovum toward the uterus, obstructs the progress of the spermatozoa, nor is it probable that the peristaltic action of the tube toward the uterus would check the march of so minute a body as a spermatozoon.

In the lower animals the presence of spermatozoa in the pelvic cavity, as well as in every portion of the genital tract, soon after coitus, has been repeatedly demonstrated. Moreover, the migration of the ovum in the human female has apparently been proved by the occurrence of pregnancy in patients in whom the ovary of one side and the tube of the opposite side had been removed. If this migratory range for both ovum and spermatozoa be admitted, the mechanical theory of ectopic gestation is thereby made reasonably plain. The inference would be, however, that such gestation would be more common, and primary abdominal pregnancy the most frequent form. This, we know, is not a fact, for even the existence of this latter variety can hardly be established.

There is then something characteristic of the tubal mucosa which allows the implantation and growth of a fertilized ovum or some element that inhibits its growth or destroys it in the pelvic cavity. Clarence Webster explains this by claiming that, beside the mechanical condition which retains the ovum, there is need of "the occurrence of certain necessary reactions in the mucosa, caused by genetic influence and producing decidual changes, such influence existing by reason of a reversion in the tubal mucosa to an earlier type in mammalian evolution."

FIG. 272.

Infundibular ectopic gestation with Fallopian tube, showing exaggerated convolutions.

A pathological condition of the ovum may favor its premature adhesion to the wall of the tube before the uterine cavity is reached. Pathological or abnormal conditions of the tube itself, however, undoubtedly form the most important factor in the causation of ectopic gestation. Chief among these may be mentioned the following: Congenital deviations from normal type, such as exaggerated convolutions (Fig. 272), diverticula (Figs. 267 and 272), and atresias; sagging and attachments by adhesion, resulting in distortion of the tube; pressure from adjoining organs; thickening of tubal walls, either congenital or acquired, diminishing peristalsis; desquamative salpingitis or hyperplasia, destroying the cilia, producing atresia; growths, either in the canal or the walls;

obscure conditions, preventing coaptation of the fimbriæ with the ovum or ovary.

Herzog, in a recent article on "The Pathology of Tubal Pregnancy,"[1] concerning this subject, says:

"The etiology of tubal pregnancy is certainly not a uniform one for all cases. It appears to me that in a respectable percentage of cases congenital anomalies of the tubes due to anomalies in early embryonic development of the Müllerian ducts are responsible for the occurrence of tubal pregnancy. I have previously, conjointly with Dr. F. Henrotin, reported cases of tubal pregnancies due to tubal anomalies.

"Another factor which I consider as important in the production of tubal gestation is an unduly marked participation of the tubal mucosa in menstruation. With others I hold that the tubal mucosa takes part to a certain extent in menstruation. Normally the menstrual changes of the tubal mucosa are insignificant compared with those of the uterine mucosa. Occasionally, however, the tubal mucosa shows intense menstrual changes, which may be so pronounced as to lead to the formation of a hæmatosalpinx. We can hardly doubt that the menstrual changes of the uterine mucosa prepare the latter for the reception of an impregnated ovum, which, as appears most probable from the latest contributions upon the subject, eats or corrodes its way into the substance of the uterine mucosa by the aid of a phagocytic trophoblast. Whenever the tubal mucous membrane undergoes extensive menstrual changes it becomes a soil into which an impregnated ovum can easily implant itself. It appears, therefore, very probable that marked menstrual changes in the tubal mucosa, when they do occur—and they occasionally are present—become the cause of an ectopic implantation of a fertilized ovum. Opitz considers that the cause lies most frequently in the formation of a cul-de-sac resulting from adhesions of neighboring folds of tubal mucous membrane, owing to previous attacks of salpingitis. If by salpingitis he refers to gonorrhea, we cannot agree with him, nor with E. Runge, who mentions alterations in the tubes produced by this disease as a prominent etiological factor in the production of ectopic gestation. They say that tubal pregnancy is often preceded by a period of sterility, but this is hardly a fact; it is more often *not* so preceded.

Cases are being reported in which the gestation sac is found developing between the layers of the tube walls, but outside of the lumen; and, as the result of many observations, it has come to be conceded that the ovum is frequently, if not usually, imbedded in the muscular coat beneath the epithelial lining, having, by a process of phagocytic corrosion, burrowed its way to this location, the active element in fixation being resident in the fœtal villi rather than in any tubal peculiarity.

It is certainly difficult to reconcile the two views herein outlined, but it may be possible that both are right, and that alterations in the tube and excessive phagocytic peculiarities in the ovum each plays a part in the production of ectopic pregnancy.

Pathology. *Changes in the Uterus.* This organ begins to enlarge, both as to its cavity and walls, simultaneously with the establishment of pregnancy in the tube. It continues to enlarge, and up to the fifth

[1] Amer. Jour. of Obstet., 1900.

month is usually one-third smaller than in an intra-uterine pregnancy of the same age. The enlargement may continue after this time, but at a less rapid rate. Rupture of the tubal pregnancy, when followed by death of the ovum, checks the growth of the uterus, and is soon followed by involution. When, however, death of the ovum does not take place, the uterus may continue to enlarge, though not to the same extent as before the accident. The uterus of an extra-uterine pregnancy at full term usually measures from four to six inches in depth. Involution of the uterus does not commence until the fœtus is dead, and decrease in the size of the uterus is an indication that this has occurred. In general terms, it may be stated that the more remote the place of implantation of the ovum from the uterus, the less the increase in size of that organ.

Decidua. One of the most notable changes in the uterus in ectopic gestation is the formation of a decidua. It partakes of the characteristics of the decidua vera of normal pregnancy, and is usually thrown off,

Fig. 273.

Scrapings from the uterus in a case of ectopic gestation in the third month.

A. Decidua vera. B. Decidua in the beginning of coagulation necrosis, showing many leucocytes. C. Blood sinus. D, D. Gland spaces. (Herzog.)

either in one complete cast or in the shape of débris, about the time of the primary tubal rupture, and this event is frequently accompanied with metrorrhagia. The casting off of the decidua may precede, accompany, or follow the rupture. The persistence of life in the ovum after primary rupture does not prevent the shedding of this membrane. The decidua varies in thickness from one-eighth to one-quarter of an inch, is rough and shaggy upon its uterine side and smooth upon its inner surface, and,

of course, in the uterus shows no traces of decidua reflexa and decidua serotina (Fig. 273).

Alterations and Changes in the Tube and Ovum. These vary greatly with the location of the gestation-sac, but swelling and turgescence are present in all cases from the beginning. This thickening consists at first in simple enlargement of the calibre of vessels due to the stimulus given by the existence of the pregnancy, then of hypertrophy of muscular fibre, the same as the first changes which take place in the uterus in normal pregnancy. Then follows the free development of connective tissue and often disappearance of muscular fibres, particularly following the evidences of minute rupture, which disintegrates and breaks them up by small extravasations and hemorrhages, and gives rise to inflammatory and cystic changes; or pressure-atrophy of the wall takes place opposite the placental attachment, which has become the thickest part of the tube.

Closure of the ostium abdominale usually takes place about the seventh or eighth week when the oösperm is retained in the middle or inner portion. When, however, it is retained near the abdominal opening, complete closure does not occur, and there is, consequently, a tendency to tubal abortion.

In the apparent exceptions to this rule in which the ostium is not closed at twelve weeks, examination of the specimen and careful analysis of the history usually demonstrate that rupture had taken place several weeks earlier.

It appears that closure of the abdominal opening may also occur much earlier than the seventh or eighth week. The writer has operated on a case of tubal pregnancy in which, as was obvious from the history and from the microscopic examination of the specimen obtained, rupture occurred in the second or third week of gestation. In this case the abdominal opening of the tube was found closed.

The formation of a decidua in the pregnant tube is now conceded by all competent observers. A number of my own cases have been examined for that purpose, and a decidua has invariably been found (Fig. 277). It has also occasionally been found in the opposite non-pregnant tube. The amount of decidua vera, however, varies considerably in different cases, but in all instances the characteristics of the true decidua of uterine pregnancy are shown; namely, the usual two layers, a superficial compact and a spongy, lower layer.

This statement concerning the presence of decidua in the pregnant tube is still denied by various observers, some of whom claim that its development is limited to the uterine mucosa and that it is not even found on the cervical mucosa except where placenta prævia exists. The decidual cell is a connective-tissue cell modified by pregnancy and has been reported as found in the pregnant and non-pregnant tube, in the peritoneum at various points, on or imbedded in the ovary, and about and on the appendix. Some even speak of a decidual reaction of the peritoneum and ovaries during pregnancy. This confusion arises because of the lack of a defined method of identifying the individual cell, and a number of pathologists assert that what are reported as decidual cells are simply connective-tissue cells from proliferated endothelium.

The enlarged vessels common to the whole tube are particularly prominent in that portion of the mucosa covered by decidua to which

FIG. 274.

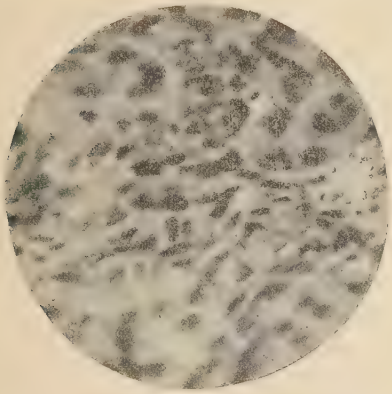
Tubal pregnancy, 2–3 weeks old (natural size).

a. Rupture and blood coagulum. *b*. Closed fimbriated extremity. *c*. Ovary.

the ovum becomes attached, and which is known as decidua serotina. This decidua serotina grows more rapidly than the rest of the decidua.

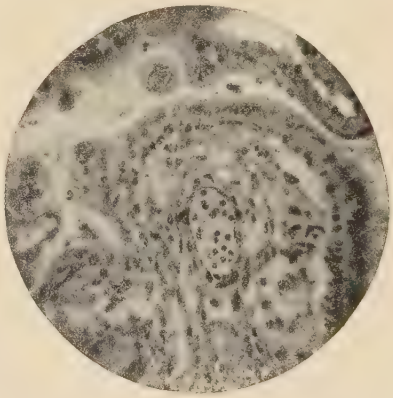
At an early period in uterine gestation an intervillous space filled with maternal blood, bounded on the outside throughout most of its extent by

FIG. 275.



Decidual cells in serotina; tubal pregnancy, 2–3 weeks old. (HERZOG.)
From case represented in Fig. 274.

FIG. 276.



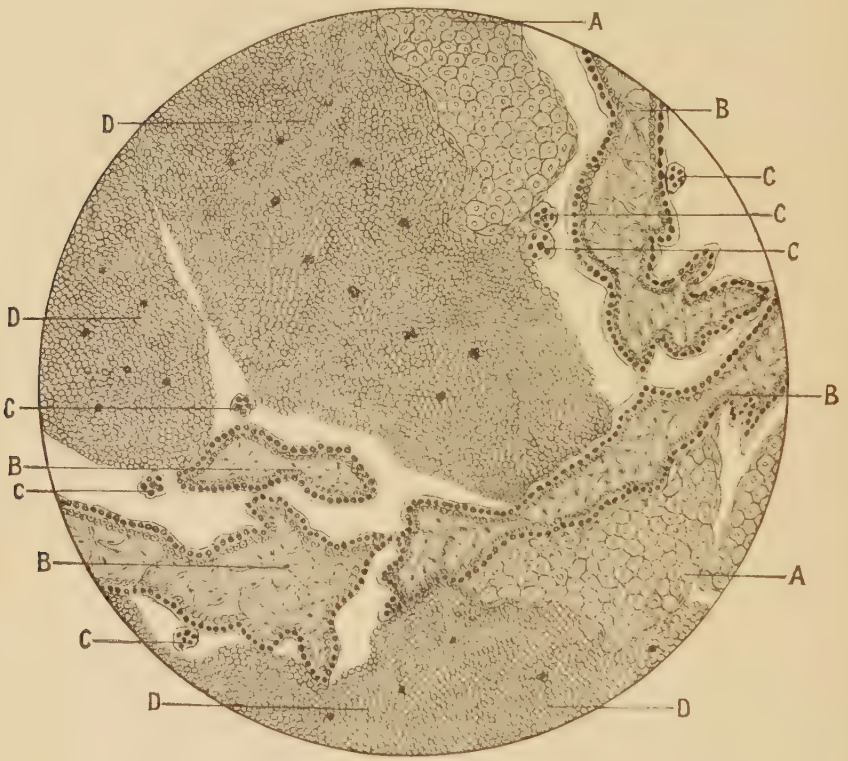
Villus highly magnified, showing Langhans layer and syncytium. In the mesodermal core a blood-vessel with nucleated red blood-corpuscles. (HERZOG.)

From case represented in Fig. 274.

the decidua reflexa, surrounds the whole chorion. In tubal pregnancy, therefore, there must also always be formed a decidua reflexa, because an intervillous space capable of retaining the maternal blood can be formed only by a decidua reflexa, unless we assume that the tube very early becomes completely obliterated on both sides of the ovum. Since we

have no proof of such a very improbable occurrence, a decidua reflexa becomes an absolute necessity for the establishment of the intervillous space (Herzog).

Fig. 277.



Section from gravid Fallopian tube. Lutz, Obj. 3; Eye-piece No. 3.
A. Decidual cells. B. Villi. C. Syncytial buds cut transversely. D. Blood in intervillous space.

Hemorrhages found in the tube are most frequently the result of rupture of the reflexal vessels. As pregnancy advances the decidual cells in the balance of the tube disappear, and inflammatory changes, the result of the minute ruptures, combined with possibly mild pre-existing septic conditions, change the general texture of the mass. The growth of the ovum stretches the lumen of the tube, which gradually becomes, together with the placenta and membranes, a part of the investing heterogeneous gestation-sac.

But little can be said in this connection of the changes in the ovum, its development and attachment being made comparatively plain if the presence of a decidua is admitted, as it thus follows the transformations usual to a pregnancy in the uterus, subject simply to the changes incident to lack of space in the tubes, and the traumatisms which must almost inevitably result, and which will be considered when speaking of the different varieties.

The true investing fetal membranes, namely, amnion and chorion,

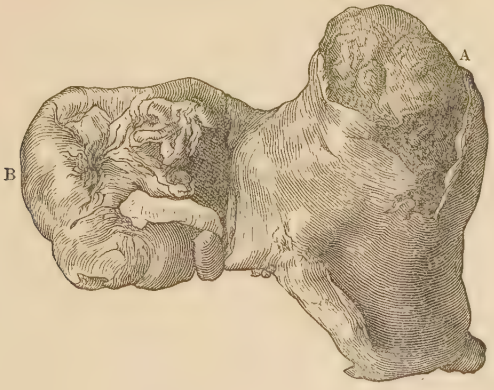
differ in no wise from the same structures in uterine pregnancy, but are also subject to the alterations incident to trauma and possible sepsis.

Tubal Mole and Tubal Abortion. The subject of alterations in the ovum can hardly be dismissed without reference to that arrest of development during the first few weeks which results in what is known as a tubal mole. An ovum during its first few weeks of growth, depending as it does for life upon very delicate chorionic villi lightly attached, is in great and constant danger of destruction. In some cases, by reason of chorionic hemorrhage, the circulation is cut off, the ovum is partially or totally detached, remains *in situ* and is absorbed, or, after detachment, particularly when located in the outer third of the tube, it may be expelled through a patent ostium abdominale into the abdominal cavity. This constitutes what is known as a tubal abortion.[1] Sometimes, however, the tube ruptures and the mole is extruded directly into the free cavity, often with most appalling symptoms.

It cannot be stated definitely that subperitoneal rupture does not occur in these early cases, for no observations bearing upon this point have, so far as the writer knows, been absolutely demonstrated. The proof of this condition must depend upon the report of a competent pathologist after thorough dissection.

A Tubal Mole resembles a blood-clot in color and consistence, is round or ovoid, and from two to six centimetres in diameter (Fig. 278). It usually presents, on section, a smooth-walled cavity, lined with amnion, occasionally containing fœtal remnants. Both amniotic cavity and fœtal remnants may be absent, but the presence of chorionic villi makes the origin manifest. Bland Sutton believes that a tubal mole "is due to blood extravasated from the circulation of the embryo into the subchorionic chamber."

Fig. 278.



Tubal mole, fifth week.

A. Mole protruding from ruptured portion of tube. B. Ostium abdominale partially closed by infolding of the fimbriæ.

Changes in the Placenta. In no case of tubal pregnancy is there absence of decidual formation, but there is a marked difference in different cases as to the extent to which this membrane is formed. Observations

[1] Tubal pregnancy, it is believed, terminates by abortion in not less than 75 per cent. of cases.—Ed.

by a number of modern competent observers, looking toward an elucidation of this question, demonstrate the almost constant presence of decidual membrane in the tube. Taking this for granted, the placenta, as in uterine pregnancy, is composed of loosely held masses of chorionic villi with intervillous blood-spaces bounded externally by varying areas of decidua serotina. The development of this organ is necessarily modified by the amount of decidua present. When to this is added the narrowed available space still further constricted by the rugosities of the mucosa and the mobility of the tube, the difficulties in the way of the development and growth of the placenta can readily be appreciated.

When, however, rupture occurs, and the torn walls of the tube spread out, if the ovum survive, the placenta forms further attachments to neighboring structures and continues its growth. The size of placentas varies directly with the vascularity of the structures upon which they become implanted and with the permanence of the attachment. From the beginning the essential elements of disturbance in the development of the placenta are traumatic hemorrhages. The tube wall early in pregnancy cannot, as a rule, accommodate itself to the growing ovum. It becomes stretched, and ruptures take place into the substance of the serotina, accompanied by hemorrhage into the intervillous space, endangering the integrity of villi and chorion.

When an ectopic placenta is examined at any period of gestation, evidences of previous hemorrhages are rarely absent. These hemorrhages are necessarily small while the mass is confined within the tube, but after rupture they may be severe and even fatal. The fatal termination is, however, ordinarily due to what may be termed "detachment hemorrhages"—that is, hemorrhages from maternal vessels consequent upon detachment of the placenta.

Independent of detachment hemorrhages, however, are the constantly recurring extravasations into the serotinal tissue. These intraplacental hemorrhages materially increase the bulk of the placenta, and produce an apparent disproportion between its size and that of the ovum. This disproportion is the foundation for the erroneous statement that the growth of the placenta continues after the death of the ovum. It is very possible that an intraplacental hemorrhage may increase somewhat, but it is hardly reasonable to suppose that the formation of true placental tissue could continue, and this has never been demonstrated. The chorionic villi degenerate and become in a very short time mere phantoms with indistinct outlines. New formation of villi is most improbable. The decidua serotina also undergoes rapid degeneration. Therefore, no real growth of placental tissue can occur after the death of the fœtus; if an increase in size takes place it must be due to traumatic hemorrhages.

The placenta is then transformed from an oval or round disk to a more or less globular mass, which, upon careful examination, is seen to be composed of blood-clots in various degrees of organization, with deteriorated villi interspersed, and a large number of leucocytes, and to contain no more than the normal amount of true placental tissue. In case of very old placentas, indeed, so marked an alteration has occurred that little normal placental tissue can be recognized.

Symptomatology and Diagnosis.

A. Prior to the Fourth Month.

General Considerations. Prior to the fourth month the three cardinal and practically constant points in the diagnosis of beginning extra-uterine pregnancy are (1) disturbance of menstruation, (2) sharp pelvic pain, usually accompanied with faintness, and (3) the presence of a mass adjacent to and connected with the uterus. Certainty of diagnosis is based upon a logical analysis of these three factors.

1. **Disturbance of Menstruation.** Menstruation is almost always retarded; but the variations as regards the amount, character, and periodicity of the hemorrhage are so numerous as to render the description of a typical case difficult. In some cases uterine hemorrhage occurs a day or two following the date of the expected menstruation; in other cases amenorrhœa persists throughout the pregnancy; the flow may continue for two or three days, and may recur with sufficient regularity to simulate menstruation, but this is exceptional. The first day of the flow is seldom or never the twenty-eighth day after the beginning of the last menstruation. Sometimes the flow continues for a day or two, and then recurs at irregular intervals; but in other cases the hemorrhage persists for weeks at a time. The amount of blood lost also varies greatly, from a mere show to a severe hemorrhage. The blood usually contains small patches of mucosa or large, well-defined membranes, and occasionally a complete cast of the lining of the uterus. These hemorrhages, regular or irregular, occurring early in ectopic gestation, usually indicate shedding of the decidua.

2. **Pelvic Pain.** The pain is usually of two kinds: the recurrent, contractile pain due to uterine contractions, and the sharp, tearing pain, accompanied with faintness, which indicates rupture to a greater or less degree. Excruciating pain with syncope usually points to serious rupture.

3. **Presence of a Mass.** When the pregnancy is located in the middle or at the outer end of the normally situated tube, and is unruptured, a well-defined movable mass, contiguous to the uterus, can be felt. When the tube is prolapsed posteriorly, the mass will be felt posterior to the body of the uterus. After rupture into the broad ligament has taken place the mass can still be felt lateral to the uterus, but it is lower, not so well outlined, and less movable. When sepsis has supervened, the presence of exudate may render the outlining of the mass still more difficult. In interstitial pregnancy the mass appears as an irregular bulging at the corner of the uterus. When early rupture into the general peritoneal cavity has occurred, no mass may be felt at all.

The nausea, changes in the breasts, and discoloration of the vaginal mucosa are confirmatory of the diagnosis of pregnancy, and, when combined with the signs detailed above, are strongly presumptive of extra-uterine pregnancy. Valuable corroborative evidence is furnished by the changes in the uterus, and by uterine hemorrhage when it occurs. The adjoining pregnancy stimulates the growth of the uterus, but not to the extent which obtains in uterine gestation of the same age. This disproportion in size becomes more marked as pregnancy progresses. Uterine hemorrhage frequently occurs before the third month of extra-uterine

pregnancy, and is usually accompanied with the discharge of decidua, which, as mentioned before, is cast off either in shreds, in large patches, or as a complete cast of the uterine cavity. The absence of chorionic villi after careful search furnishes another link in the chain of evidence. At this stage of the investigation exploration of the cavity of the uterus is warrantable. When, after careful introduction of a sound into the uterine cavity, the uterus is adjudged empty, the diagnosis of early ectopic pregnancy is practically established.

Primary Intraperitoneal Rupture—Hæmatocele. In the great majority of cases, gravid Fallopian tubes rupture prior to the fourth month. This is known as primary rupture, to distinguish it from subsequent ruptures which may occur in the same pregnancy. Primary rupture may be intra- or extraperitoneal. Experience demonstrates that primary intraperitoneal ruptures generally occur prior to the seventh week, and so frequently in the fifth or sixth week after the last menstruation that pregnancy is not suspected. As women with pre-existing pelvic disease are especially prone to extra-uterine pregnancy, menstrual irregularities easily escape attention.

The diagnosis of primary intraperitoneal rupture prior to the seventh week is the diagnosis of intra-abdominal hemorrhage. The absence of marked disturbance of menstruation does not preclude the existence of early rupture. The failure to observe the discharge is not significant, for this may occur simultaneously with the rupture, or may closely follow it. The physical signs are identical with those of intra-abdominal hemorrhage.

The case illustrated by Figs. 274, 275, and 276, though extremely rare and the only one of its kind on record, shows the difficulty of diagnosis when reliance is placed on some retardation of menstruation. In that instance the patient had menstruated regularly for years, and pregnancy occurred, followed by rupture both within four weeks and before the time for the next period to make its appearance.

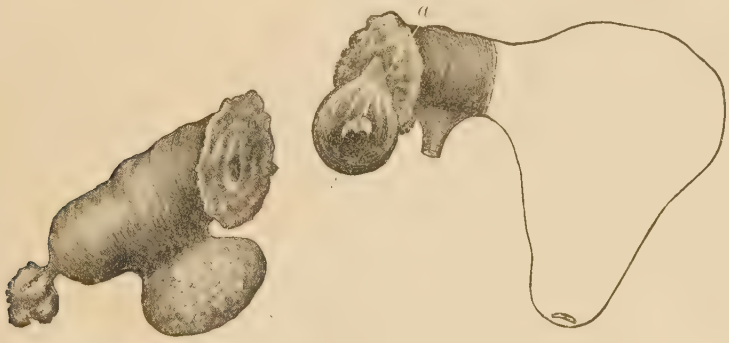
The failure to recognize a tumor near the uterus is not very important. Thorough examination is difficult on account of the condition of the patient. Even when the intra-abdominal hemorrhage is enormous, the chief reliance must be placed upon the general conditions of shock and collapse, as the presence of blood can seldom be demonstrated by fluctuation, abdominal palpation, or bimanual examination. A symptom rarely absent, however, is exquisite general abdominal tenderness. The ovum may be so small as to produce no appreciable enlargement, or it may have been expelled into the general peritoneal cavity.

The following case furnishes an excellent illustration of the symptomatology of primary intraperitoneal rupture.

On September 15, 1894, Mrs. J. P. C. was seized with a severe pain in the abdomen, which she described as feeling "like something breaking in her stomach." Simultaneously there was a gush of bright, pinkish, watery fluid from the vagina, which flooded her thighs and saturated her clothing. She was seen by a physician at 1.30 P.M., and by another an hour later, and at 5.30 by the writer. At that time she was almost *in articulo mortis*, and absolutely pulseless and perfectly cold. The patient was thirty-three years of age, had been married twelve years, and had three children, aged, respectively, ten, five, and three years.

She had never had a miscarriage, and, so far as she knew, had never had uterine disease of any kind. She was a woman of magnificent physical development, weighed 230 pounds, and was full of courage. She had always menstruated regularly; but for several years had flowed for six or seven days at a period. On August 12th, exactly five weeks previous, she menstruated regularly, and the flow continued for six days. On August 29th, without warning, she suddenly had a severe pain resembling a labor pain, which continued for ten minutes, and was accompanied by nausea and vomiting. On August 31st, while travelling on the cars, this pain recurred and lasted half an hour. While away from home she had two or three short, severe pains and a slight diarrhœa.

FIG. 279.



Primary intraperitoneal rupture; fifth week. Tube completely ruptured.
a. Ovum still slightly adherent to its original site.

On September 9th, after her return home, she began to menstruate exactly on time, but the flow was checked by a sudden fright, her son being seized with convulsions in her presence. The same evening she had another short, acute attack of abdominal colic. The menstrual flow returned the next day, but ceased after a few hours. It again returned, but ceased two days before the final attack.

When first seen by the writer it was evident from the profound collapse, indicated by the total absence of radial pulse, and the excessive pallor and death-like coldness of the body, that the patient was suffering from internal hemorrhage; while the dyspnœa made it plain that the time for action was short, and that if something was not immediately done it would be too late. Further physical examination revealed nothing more than local tenderness over the whole abdomen. Sudden pressure would elicit repeated expressions of pain.

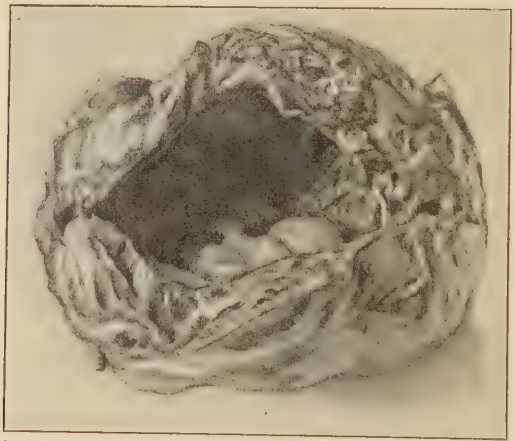
A careful and thorough vaginal examination was made, which was entirely negative. The fact that she was flowing at the time, of course directed my attention to the pelvic organs as the probable source of hemorrhage, and the information obtained from the patient's friends and from herself, regarding the previous attacks of pelvic pain, made the diagnosis of ruptured tubal pregnancy more than probable. Two objects were therefore kept in mind in making the examination. First, the determination of the presence of free blood in the abdominal cavity, and, second, the discovery of a mass to one or the other side of the

uterus. The examination failed, however, in both respects; repeated percussion over the abdomen absolutely failed to give any impulse or sense of fluctuation, either upon deep digital pressure into Douglas's pouch or at either side of the uterus, and no enlargement of the Fallopian tubes could be detected. The thickness of the abdominal walls in this patient greatly increased the difficulty of and embarrassed the examination.

The correctness of the diagnosis became evident even before the peritoneum was incised. After the incision was made and the intestines pushed back, the blood surged out over the surroundings. A careful estimate of the amount of blood in the abdomen would place it at not less than eighty ounces. The right Fallopian tube was found to be widely ruptured at its middle and the ovum embraced by the gaping edges of the wound (Fig. 278). The lumen of the tube was perfect excepting at the seat of rupture.

The fimbriæ were partially drawn into the abdominal ostium. There was a great attenuation of the tubal wall at the location of the tear, which occurred at a point opposite to the seat of attachment of the ovum.

FIG. 280.



Unruptured ampullar pregnancy at the end of the second month (embryo about 2 cm. long. The thinnest part of the gestation sac has been removed after the operation.

Primary Extraperitoneal Rupture—Hæmatoma of the Broad Ligament. An extra-uterine pregnancy, instead of developing in the direction of the free abdominal cavity, may grow downward and cleave the folds of the broad ligament without rupture of the tube proper, the adjoining portions of the broad ligament stretching gradually to accommodate the growing ovum. As a rule, rupture occurs between the seventh and twelfth week of pregnancy.

Here we have, first, the usual signs of extra-uterine pregnancy, together with the constant presence of a mass contiguous to and connected with the uterus. Rupture is indicated by an increase in pain and faintness. The signs before this accident are often not sufficiently marked to denote the character of the pregnancy, and, as a rule, the patient believes herself pregnant in the normal way. Whereas, in the early primary intra-

abdominal rupture faintness and syncope are the most striking symptoms, and the pain not so severe, in this variety severe pain is usual, while the collapse is not so extreme. The pain in most cases is recurrent and paroxysmal, coming on without warning and usually soon passing away, to be followed by another series of paroxysms a few hours or a few days later, each attack probably indicating an extension of the rupture. As the blood effused is limited by the resistance of the adjoining structures, we do not witness those appalling symptoms common to the already mentioned intraperitoneal ruptures.

To make the picture plain regarding these cases, if a woman of child-bearing age suddenly complains of severe pelvic pains, accompanied by nausea and faintness; if, on investigation, she says that she has missed one, two, or three menstrual periods, or has flowed in a very irregular manner, and thinks herself pregnant; if she has the usual vulvar and vaginal discolorations common to pregnancy and the changes in the breasts, with nausea, and if these attacks of pain and faintness recur, extra-uterine pregnancy must be strongly suspected. If, on examination, the uterus is found enlarged, but not to a sufficient degree to correspond to a pregnancy of that age, while immediately adjoining the uterus and continuous with it a tense and vaguely fluctuating enlargement is discovered, then ectopic gestation, ruptured extraperitoneally, is a reasonable conclusion, and the case may be so regarded and treated. The signs mentioned may not all be present, and many cases are sufficiently obscure to bring doubt, but to the experienced surgeon there are usually landmarks enough to outline the course to pursue.

Early cases of this kind undoubtedly occur which are not diagnosed, the ovum and secundines being gradually absorbed and the patient never being very ill; but when the accident takes place after the seventh week severe illness generally ensues. Even at ten and twelve weeks the rupture may have proceeded so evenly and slowly that the patient may not seek medical advice until constitutional symptoms indicative of sepsis appear.

In the very great majority of cases the ovum dies at the time of the rupture, and no further growth occurs. The traumatism existing, however, leads to the formation of protective exudate, which very materially increases the size of the whole mass. This increase in size gives rise to more pronounced pain, and sooner or later, in almost all cases, sepsis supervenes and the mass breaks down into a suppurative focus, while the patient develops fever, sweats, chills, and the usual constitutional evidences of retained septic material.

In patients seen for the first time in this condition, the diagnosis is often difficult, and in some, where the history is not very typical, is even impossible, as the signs differ little from those of the common forms of septic pelvic invasion. Careful inquiry into the history is the best reliance for avoiding mistakes.

Secondary Ruptures. This term applies only to the last-named variety, namely, the extraperitoneal variety, where the ovum, after forcing its way below the peritoneum in the folds of the broad ligament, ruptures into the general peritoneal cavity. These secondary ruptures may occur from different causes. After the primary rupture the ovum may survive, and its continued growth almost invariably results in communication with the general cavity. This variety of secondary rupture is sometimes

sudden, and the effusion of blood into the general cavity may be so extensive as to give rise to the most serious symptoms with fatal results. The appearances are very similar to those of primary rupture of early date, and the treatment must be equally prompt. A secondary rupture may follow a primary rupture so closely that they can hardly be differentiated.

In other cases, however, *the ovum surviving*, the secondary rupture may be slow and not extensive, the opening reinforced by quickly formed exudate and the symptoms more subdued. Such accidents may occur time and time again, and, if the ovum is not destroyed, there develops that class of so-called advanced, abdominal, extra-uterine pregnancy which will hereafter be described.

When the *ovum is destroyed* by the *primary rupture*, secondary ruptures may still occur. If the first rupture has so separated the ligamentous folds that only a thin peritoneal membrane is interposed between the mass and the general cavity, blood-pressure alone from recurrent hemorrhages may complete the rupture; or, the whole mass including its peritoneal covering becoming macerated and softened by sepsis, secondary rupture may result from lack of consistency.

The interstitial or tubo-uterine and infundibular or tubo-ovarian varieties of ectopic gestation are especially prone to early primary intraperitoneal rupture. In the true tubal variety, if the placenta is implanted on the superior inner surface of the tube, extraperitoneal rupture is more likely to occur; if, on the contrary, it is implanted on the lower inner surface, the upper part of the tube thins out, and early rupture into the general peritoneal cavity is most probable. Almost all the extraperitoneal ruptured cases belong to the true tubal variety.

B. After the Fourth Month.

Unruptured Tubal Pregnancy. When the ovum survives all the dangers which threaten its existence, new signs become evident after the fourth month which demand separate consideration in their relation to diagnosis. Few ectopic gestations survive the fourth month, and very few, indeed, of these have not been subject to more or less rupture, either intra- or extraperitoneal. Most of the reports of examinations of extra-uterine cases are not sufficiently minute and explicit to form a positive opinion; but, nevertheless, there can be no doubt that women have passed through extra-uterine pregnancy to term, carrying the child within the enlarged dilated tube, without appreciable rupture in any direction. Many of the reported cases of this variety have, however, been shown to have previously ruptured slowly below, between the folds of the broad ligament.

Abdominal Pregnancies Without Rupture. The space at command will not admit of reviewing the discussion whether such a condition can exist. Suffice it to say that advocates of that theory believe that an impregnated ovum can find its way into the general cavity or that an ovule can there become impregnated and implanted, and grow even to full term without rupture. Their opponents stoutly maintain that all so-called abdominal pregnancies were originally tubal, that rupture took place into the general abdominal cavity, but that sufficient attachment to the tubal mucous membrane remained to nourish the ovum, and that eventually, although the placenta became universally attached to sur-

PLATE XXX.

Left Tubal Pregnancy Operated on Five Months after Signs of Life had Disappeared. The superior surface of the left tube is still visible on the surface of the sac. The left ovary was visible only as a bluish flattened patch apparently forming a part of the sac wall. The sac developed between the folds of the mesosalpinx and mesosigmoid. The patient was suffering from uterine hemorrhage, but had never been seriously ill. There had never been signs of rupture, and the whole sac was dissected intact into the cornua of the uterus.

rounding structures, all cases that were examined with sufficient care by competent authorities could always be traced to the tube as the original site of primary implantation. The consensus of opinion at this date inclines to the latter view. (See Plate XXX.)

In almost all cases of advanced ectopic gestation we have the symptoms and signs common to uterine and ectopic gestation, namely:

Disturbance of menstruation;
Changes in the breasts;
Enlargement of the uterus;
Nausea;
Changes of the vulva;
Thinning out and softening of the lower uterine segment;
Mucous vaginal discharges;

as well as the symptoms heretofore described as resulting from rupture of greater or less extent in the earlier months.

As the gestation advances beyond the fourth month the other signs which become manifest demand special consideration. Of these the principal are: (1) changes in the breasts characteristic of advanced pregnancy; (2) movements of the fœtus; and (3) abdominal enlargement; while careful examination often reveals (4) ballottement; and (5) placental souffle.

1. **Changes in the Breasts.** These are practically similar to the changes which occur in uterine pregnancy, but are generally not so well marked; the areola is not so well defined, the breast not so full, nor the secretion so abundant.

2. **Movements of the Fœtus.** The perceptibility of these movements differs according to the variety of the case. When dealing with a case of so-called abdominal pregnancy, the result of secondary rupture into the free peritoneal cavity, if the patient is reasonably thin, the movements are often extremely plain to the examiner, even when hardly noticeable to the patient. When near term and the child is reasonably vigorous, the movements may be felt and seen so plainly immediately beneath the abdominal wall as to form a valuable diagnostic sign. In the subperitoneal forms the movements are not so plain, but may be very painful to the patient, although they closely resemble those of the fœtus in utero. Generally speaking, if the pregnancy advances to the fifth month, the movements of the fœtus are thereafter more plainly discernible than are those of a uterine pregnancy of the same age.

3. **Abdominal Enlargement.** Proper and painstaking observation of the abdominal enlargement of a woman supposed to be with child extra-uterum is a matter of the very greatest importance. While the ovum is small and the mass containing it is buried in the pelvis, the abdomen is, of course, not enlarged. When the enlargement becomes discernible, it differs according to the variety of the case. In general, it may be said that it differs materially from normal gestation in that it is not so symmetrical nor is it, at first, so centrally situated. If the patient is the victim of an interstitial pregnancy it may show very soon after the third month, usually slightly to one side. If the gestation is free tubal and subperitoneal the enlargement will usually show first on the side affected, generally resonant from superimposed intestines and more or less irregular and nodular; while if abdominal it will be still more irregular and

nodular, the mass plainly recognizable, and unless adhesions have formed to the intestine it will be dull on percussion. The mass is often wider from side to side and differs essentially from the smooth ovoid of the normally pregnant uterus.

Bimanual examination, rectal and vaginal, of a six to seven months' ectopic gestation will for the experienced examiner throw much light upon the nature of the case. The uterus at this stage can usually be outlined, and a well-marked groove between the uterus and sac can often be made out. Great care must be taken, however, in reaching a definite conclusion: A pregnant retroflexed uterus in some cases is most deceptive, while an advanced unruptured true tubal or interstitial pregnancy may be so intimately blended with the uterus as to make the outlining of that organ well-nigh impossible. In true tubal unruptured pregnancy and in the ruptured subperitoneal variety a sign of importance is the obliteration of the vaginal fornix on the affected side. (See Plate XXXI.)

In cases where there have been repeated ruptures with hemorrhages surrounded by exudate, the diagnosis is sometimes very difficult, the abdomen and pelvis being filled with irregular masses varying in size from small nodules to lumps the size of a fist, and the whole matted together by adhesions. The uterus is adherent to these masses, fused among them, and often indistinguishable from them.

The fœtus itself may be palpated sometimes with the very greatest ease, and the extreme thinness of the tissues between the overlying hand and the fœtus is often quite a characteristic sign. Palpation of both fœtus and uterus is frequently rendered difficult, however, by the implantation of the placenta upon the anterior wall of the sac.

If the sac is interstitial it may still retain its central location, but its length will be out of proportion to its breadth. If tubal, the uterus will usually be pushed to one side, and almost always be crowded up behind the pubes, as in the majority of cases the sac settles down in Douglas' pouch. If the pregnancy develops very low down, and if adhesions do not form, the uterus may be so crowded up that the cervix can hardly be reached. The size of the organ does not correspond to the age of the suspected pregnancy, varying, when the case is at term, from four to six inches in depth. In some women examined at this time, the nature of the case is most apparent, the important item of diagnosis being the outlining of the uterus proper and the determination of its location as independent of the sac.

4. **Ballottement** may be elicited either anteriorly or posteriorly to the uterus.

5. **Placental Souffle.** This sign, common to normal as well as to extra-uterine pregnancy, is of significance only in a small proportion of cases. It begins to be heard about the end of the third month, but is often very faint. In secondary abdominal ruptures, when the placenta spreads out anteriorly just beneath the abdominal wall, it may prove a valuable sign, as it is then extremely loud, is sometimes spread over almost the entire abdomen, and by its intensity, suggests the character of the case.

General Conclusions Concerning Signs and Diagnosis. From a perusal of the foregoing remarks on the signs of ectopic gestation it becomes evident that the existing variations are misleading by reason of their great

PLATE XXXI.

Secondary Abdominal Pregnancy at Eight Months, Primarily Tubal. The primary attachment of the placenta is plainly discernible at the original tubal site. After rupture the placenta grew and became attached to a large surface on the anterior abdominal wall. The child was delivered through a retro-uterine vaginal incision.

diversity, and yet the diagnosis, after a time has elapsed, is not usually attended with as much difficulty as might be inferred.

Diagnosis is well-nigh impossible in patients who come under observation early in pregnancy and before any degree of rupture has occurred. There are then present evidences of pregnancy and a mass adjacent to and, moreover, connected with the uterus. If such a patient has been carefully examined within four or five months, or just before the beginning of the ectopic gestation, and no mass found, the recent appearance of the latter becomes extremely significant. If no such opportunity has been offered, however, there is often little, if anything, to differentiate between the gestation sac and a possible cystic enlarged ovary, a dermoid cyst, or any condition characterized by such an enlargement and not inconsistent with pregnancy.

One can seldom be certain in this class of cases. Beside the signs of pregnancy and the presence of the enlargement alluded to, it can only be mentioned as an aid in diagnosis that there is usually more pain, which the patient describes as griping or colicky, coming on sharply and leaving suddenly, to be soon repeated, usually lasting from a few hours to a day or two, and followed, it may be, by a respite for a few days, when another series of pains occurs. The lump felt near the uterus may also be said to be rather soft and possibly slightly fluctuating; it is generally unattached and movable and throbbing because of enlarged vessels.

If hemorrhage occurs from the uterus, however, very great assistance is derived from a microscopical examination of the discharge, as by this is often revealed the presence of decidual cells and the absence of chorionic villi.

When primary rupture into the abdomen occurs very early, say from the fourth to the eighth week, the hemorrhage in the abdominal cavity is usually large, and these cases present a most striking and almost unmistakable picture.

Subperitoneal ruptures take place from the seventh to the twelfth week of pregnancy. Before rupture the paroxysms of pain are more frequent and the pains more severe, and the shock resulting from the rupture is not so great. Examination at this time reveals a large semi-fluctuating mass filling one side of the pelvis, more or less obliterating the vaginal sulcus on that side, with a broad base and so intimately blended with the uterus as to make the outlining of the latter difficult.

In secondary ruptures in the peritoneal cavity we find the symptoms just described under subperitoneal rupture, followed by those which belong to primary ruptures.

The symptoms of advanced ectopic gestation are the symptoms of advanced pregnancy with infinitely more general abdominal disturbance than is usually found in uterine pregnancy of the same age. These disturbances are due not only to the conditions already described, but to innumerable, accidental, coexisting complications.

In the subperitoneal variety displacement of contiguous organs must necessarily occur. The bladder, uterus, rectum, ureters, and kidneys are always more or less displaced or compressed, with resultant disturbance of function. Hence we frequently observe dysuria, indigestion, and constipation, even to the point of obstruction, or it may be hydronephrosis or

nephritis, with or without eclampsia, and excessive œdema from compression of the vessels.

Peritonitis, which is a constant complication, is especially severe in the abdominal variety. Whereas, fatal general peritonitis is sometimes set up by the rupture of an early tubal pregnancy, in advanced pregnancy it usually assumes a more chronic type, producing great alteration in the sac-wall and universal adhesions, so much so that the relations of the various structures are recognized with difficulty.

Hemorrhage is also very common, not the excessive hemorrhage into the peritoneal cavity which occurs in early pregnancy, but repeated, small hemorrhages circumscribed by surrounding adhesions.

Pain is the dominant symptom in the vast majority of cases of advanced ectopic gestation with or without rupture. A few cases have, however, been observed in which a child has been carried to term extra-uterum without excessive pain. These were probably cases of unruptured true tubal pregnancy, and are extremely rare. Pain is the natural result of the visceral displacement, of the repeated hemorrhages, of the pressure upon nerves, and of the peritonitis. The pain which many women suffer in the later months of ectopic gestation is agonizing.

False or Spurious Labor. When the fœtus has reached term, spurious or false labor supervenes. It may, however, occur earlier, at the seventh or eighth month. This peculiar phenomenon has attracted much attention and given rise to many conjectures, but no very satisfactory explanation of its occurrence has been advanced. It differs materially in different patients, being sometimes abrupt, well marked, and consisting of defined contractile pains, gradually increasing in severity and lasting from a few hours to one or two days, and after reaching a certain degree of intensity gradually subsiding, it may be, never to return. In other patients it recurs a number of times several days apart, so that a woman may have had a number of so-called spurious labors. There is really but one true labor, and that follows or rather causes the death of the child. Pains recurring later are probably due to inflammatory changes in the gestation sac or to some complication. In some patients the movements of the fœtus become gradually fainter, and the signs of active living pregnancy subside without the occurrence of false labor.

Often during such labor the movements of the child become excessively active; when the climax of pain is reached all movements suddenly cease and the pains gradually subside.

Accompanying these labor pains there is usually hemorrhage from the uterus, sometimes very slight, at other times very profuse, and if decidual membrane remains it is generally expelled. Are these pains caused by contractions in the uterus or in the gestation-sac? The changes that take place in the uterus, the expulsion of membrane in some cases, the almost constant occurrence of hemorrhage, indicate that in all cases the uterus contracts, but it seems almost impossible for notable contraction to occur in the wall of a gestation-sac, often hardly thicker than parchment, and which possesses almost no muscular tissue. Probably contractions in the sac proper occur only in the subperitoneal, true tubal and interstitial varieties, where the sac wall still contains a good deal of muscular tissue.

Changes After Spurious Labor. Well-defined spurious labor always

results in death of the fœtus; following this there is subsidence of the abdominal swelling and involution of the uterus, accompanied by moderate lochial discharge resembling that of uterine pregnancy, but not so profuse. The placental souffle gradually disappears, being seldom noticeable after two weeks. The breasts may discharge milk for a few days. Well-marked and immediate decrease in the size of the abdomen is not constant, sometimes because of delay in absorption of the liquor amnii or because of increase in the placental bulk, caused by hemorrhage from vessels ruptured during the spurious labor or disintegrated by septic changes.

Sometimes following spurious labor septic symptoms appear, hectic fever develops, and the whole gestation-sac breaks down into a suppurative gangrenous mass. The pus burrows in various directions, almost always finding its way into some adjoining organ or through the abdominal wall, whence it is expelled, the disintegrated remains of the fœtus following the same channel. Numerous cases of gradual expulsion of the different parts of fœtuses by way of the bladder, rectum, vagina, or abdominal wall are recorded in the literature. Very few, if any, advanced cases are mentioned as opening into the general peritoneal cavity and proving fatal by rapid septic peritonitis, because when the gestation-sac reaches certain dimensions the pressure and inflammatory changes obliterate the general cavity and all the neighboring organs become intimately adherent to the outer surface of the sac so that there is no free cavity for the pus to break into. This process of maceration, suppuration, and expulsion, however, is usually fraught with infinite pain and imminent danger to the unfortunate victims, many of whom die exhausted by hectic fever.

In a reasonable proportion of these cases the fœtus and its investing membranes and placenta undergo peculiar and interesting changes without septic symptoms, these changes resulting in the abdominal inclusion of the modified fœtus, now styled *lithopedion*. This term is supposed to apply only to calcified fœtuses, but is generally used to signify a fœtus retained for a long time without putrefaction and suppuration.

The changes may result in mummification, or calcification, or adipocere formation of the ovum, or the sac, or both, the same specimen frequently showing the various formations in different locations.

Mummification seems to result from absorption of all the fluid portions of the fœtus, and it may be of the sac and placenta, the hard bones remaining more or less intact, and the soft parts having the appearance of dark-brown, shrunken parchment.

Calcification means hardening of all the parts from impregnation with lime salts.

Adipocere formation refers to that condition in which the soft parts of the fœtus and even portions of the bone are converted into a soft soapy mass, supposed to be due to a combination of the fats and ammonia.

A fœtal sac which has undergone these changes may remain *in situ* for an indefinite number of years. It is reported that many of them have been carried without harm for thirty, forty, and even fifty years, being then demonstrated post mortem. At any time, however, even after many years, without apparent cause, infection of the sac may occur, attended

with all the dangers described as resulting from primary septic infection, such as happens immediately after spurious labor.

Treatment.

1. Prior to the Fourth Month.

General Considerations. Surgery offers the only treatment of value in ectopic gestation prior to the fourth month. In exceptional cases operation is not advisable:

When the patient is moribund, operation is useless.

When the patient is recovering, watchful expectancy may be all that is necessary. A blighted ovum can unquestionably be absorbed. The patient may not come under observation until recovery is well under way. If a mass, the character of which is undoubted, is painless on palpation, is known to be decreasing in size, and is becoming firmer in consistency, and if the patient presents no symptoms, under such circumstances operation would be meddlesome interference.

When the diagnosis is obscure. The ovum may be expelled through a patent ostium abdominale into the general peritoneal cavity, and be there absorbed, or it may perish and be absorbed *in situ*, or intra- or sub-peritoneal rupture may take place and the symptoms not be sufficiently marked or severe to establish a diagnosis or to demand exploratory incision.

Morphine injections into the gestation-sac or the passing of a strong electric current through it, with or without puncture, are measures which were much in vogue in former years, the rationale of such measures being the destruction of the life of the fœtus, trusting to nature to absorb the products of conception. Experience has proved beyond doubt the inferiority of these methods of treatment. It is often impossible to determine whether the fœtus is alive or dead, and its death, in the majority of instances, is not followed by absorption with cure of the patient. The employment of these measures does not make the diagnosis clear when there is doubt, and, beyond all, the manipulation and interference incident to their thorough application have proved at least as dangerous as operation.

In no department of surgery have the results been more brilliant, more perfect, and more life-saving than in the modern surgery of early ectopic gestation.

(*a*) Before Rupture.

Unless one of the above-noted exceptional conditions exists, unruptured ectopic pregnancy prior to the fourth month should always be removed. This is usually best accomplished by median abdominal section with removal of the affected tube and its contents. The operation is extremely simple, as adhesions are not usually present. A ligature is placed on either side of the mass, and the latter excised completely, bleeding points being caught and, if necessary, ligated. The cut surfaces are brought together by means of catgut sutures, thereby maintaining the function of the broad ligament in supporting the uterus in position, and another overhand continued suture, to cover traumatism and sutures with

peritoneum, thereby preventing adhesions, adds to the safety of the patient. Although we usually employ catgut, the objections to silk are not of importance, for no septic focus is encountered, and if the operation be properly performed, without the introduction of sepsis, the convalescence will be rapid and without complications.

When the pregnancy is of the interstitial variety an incision is made through the muscular layers down to the sac, which is then shelled out carefully, the bleeding being checked by one or two layers of buried sutures, care being taken to cover the seat of operation with peritoneum by fine superficial sutures. In these cases it is particularly important not to close the abdominal cavity until all oozing has ceased.

(*b*) After Rupture.

1. Primary Intraperitoneal Rupture. In speaking of the symptomatology of this phase of ectopic gestation the statement was made that "The diagnosis of intraperitoneal rupture is the diagnosis of intra-abdominal hemorrhage, and the physical signs are identical." It may now be added that the treatment is that of intra-abdominal hemorrhage. The responsibility in some of these cases is immense; but the operator must not hesitate. Such patients frequently die in a few hours. The abdomen must be opened and the bleeding point ligated. The symptoms are usually very acute and the hemorrhage most abundant. After the diagnosis is established, the operation should be performed even if the patient has rallied, for the next hour may witness a new and, this time, fatal hemorrhage. Such patients are never safe, for they bleed repeatedly, and there is a gratifying uniformity of success following all these operations when the patient is not moribund.

Acute Early Primary Ruptures with Free Abdominal Hemorrhage Should Always be Operated by the Abdominal Route. A woman suddenly faints, immediately receives competent medical assistance, but notwithstanding all treatment, in an hour or two is in profound collapse with the clinical signs of early primary rupture of ectopic gestation. This is a typical fulminant case, and the patient is bleeding to death. Abdominal section should forthwith be made and direct ligation applied. Fill the bowel with normal salt solution; place the patient in the Trendelenburg position, on the bed, if need be; thoroughly cleanse the field of operation; open quickly; dip the hand at once through the blood down to the point of rupture; place a clamp on each side of the rent; wipe away sufficient blood to enable ligatures to be passed; sweep the open hand a few times around the abdomen and remove the large clots and possibly the product of conception; exsect the tube; make sure of the hæmostasis and immediately close. The hemorrhage from the bleeding point can often be controlled in four or five minutes, and the operation completed in fifteen. During all this time, if necessary, continuous infusion of physiological saline solution into the cellular tissue is being made by an assistant.

Complete removal of the ruptured tube is not always necessary. In exceptional cases it may be found, after cleansing and removal of clots and fœtal remnants, that the injury to the tube is slight and can be repaired by a few well-placed sutures, which control all bleeding.

If during the operation septic material is encountered in the abdominal cavity, be it exudate around the affected tube or disease of the other tube, or doubtful conditions in the region of the appendix, it may be permissible to remove the appendix, resect a portion of an affected ovary, replace and sustain a retroverted uterus, or perform any simple additional operation of short duration, if in the judgment of the operator the added traumatism will not increase the danger and will make recovery more certain and complete. When there is doubt concerning the aseptic character of the work performed, the abdominal cavity should be cleansed as perfectly as the patient's condition allows, after which drainage would better be employed through the lower end of the wound or through the vagina. If, however, the patient's strength will not allow such prolongation of the operation, time may be saved by the introduction of a large Mikulicz drain.

In arriving at a proper conclusion whether or not in a case of this variety the patient will still be able to bear operation, a symptom of considerable importance is the presence of great restlessness, as it frequently means impending death, and, therefore, might directly contraindicate interference. No matter how profound the shock, a patient is very seldom beyond hope of safety by rapid operation if she does not exhibit this restlessness.

Discrimination should be employed, if possible, in differentiating between recurrent temporary swoons and profound progressive collapse, and it should be remembered that the shorter the time between the beginning of the attack and profound collapse the more urgent the need of immediate operation.

Blood is left free in the abdominal cavity when the conditions of asepsis are supposedly maintained, because the shorter the operation the better the prospective recovery; the less the manipulations, the less the absorptive powers of the peritoneum are impaired, and because the absorption into the circulation of the serum left in the cavity begins at once and stimulates the patient pending the general revival of vital forces.

The Trendelenburg position is advised because the presence of large quantities of blood in the pelvis frequently interferes materially with the proper application of ligatures; because inversion of the patient lessens the syncope.

In the primary intraperitoneal rupture of interstitial pregnancy the treatment is exactly the same as that just described, for the symptoms are, if possible, more acute, except that it is not always necessary to exsect the tube, as the cavity which is left after complete removal of the ovum is closed by successive layers of sutures. If the gestation has materially advanced before rupture occurs, the traumatism inflicted upon the uterus may be so serious as to necessitate hysterectomy.

2. **Subperitoneal Ruptures**: Subject to the exceptions noted under the head of general considerations, removal of the offending gestation-sac is the proper treatment for the cure of patients affected with subperitoneal rupture. As the hemorrhage in these cases, however, is restricted by the surrounding structures, the symptoms are less acute and alarming, and the shock not so great, although the pain is often much more severe.

Although there is no doubt that many of these cases would recover by

the unaided efforts of nature without operation, the latter is much to be preferred when the patient is seen soon after the rupture, because it eliminates many possible dangers, usually saves the patient much pain, and in the great majority of instances results in recovery with complete and perfect physiological functions. When the patient does not come under observation until a considerable time has elapsed since the rupture, either she is convalescent or is suffering from complications, the treatment of which will presently be described.

Acute non-septic subperitoneal rupture should also always be treated by median abdominal section. Especial care should be taken in opening the abdominal cavity when, as frequently happens, the rupture does not occur until the tenth to the fourteenth week, for adhesions may be present and the contents of the sac be septic. The Trendelenburg position materially facilitates the operation. After the abdomen is opened the first step, and one of great importance, is carefully to wall off the affected area with pads of aseptic gauze so as thoroughly to protect the healthy portion of the cavity and its contents. If fluctuation is evident in a portion of the mass, a very small incision is made to open this part first, or a trocar may be introduced, and the liquid contents caused to flow out slowly, being caught on large gauze sponges. The whole mass is then shelled out of its bed and the vessels ligated. In some easily accessible cases the vessels may be ligated first. Occasionally the hemorrhage is very free, and a Mikulicz pelvic tamponade becomes advisable.

3. Secondary Ruptures. The treatment of secondary ruptures is similar to that of the primary intraperitoneal form. The most important item to be kept in mind is the liability of the contents of the sac to be septic; therefore, the patient should not be placed in the Trendelenburg position until the abdomen is opened, the parts, if possible, well isolated, and the peritoneal cavity cleansed to the extent that the condition of the patient will allow.

Septic Cases and the Vaginal Incision. When a patient has passed safely through the first stage of rupture without operation, she may, and very frequently does, suffer from various complications, many of which are the results of sepsis. The woman with primary or secondary intraperitoneal rupture may die in a few days from general diffuse peritonitis. As soon as such a condition is recognized an abdominal incision should be made, the cavity carefully mopped out or irrigated with warm normal salt solution, if it seems impossible to cleanse it properly with gauze, after which a large drain may be left protruding through the lower angle of the abdominal wound, or through an opening made into the posterior vaginal cul-de-sac, or both. These extremely dangerous cases are, fortunately, rare.

Generally the sepsis is local, involving at first only the gestation-sac and the affected tube and the blood-clots resulting from the hemorrhage at the time of rupture. Exudate protects the general peritoneal cavity. If suppuration follows, adjoining organs may become involved, and pelvic abscess, with all its possible destructive lesions, result. With a milder form of sepsis suppuration may not occur, but fibrino-plastic exudate may eventually bind together all the affected parts and the adjoining organs in a conglomerate mass, giving rise to innumerable functional disturbances.

In all these septic cases, if the mass is situated well down in the pelvis, vaginal incision with drainage is frequently the most desirable operation and is followed by the happiest results. The danger of hemorrhage usually disappears when septic conditions become manifest, because the vessels are occluded or much lessened in calibre.

A wide incision is made through the posterior vaginal fornix, the mass thoroughly penetrated and broken up, and most of the débris removed. Abscess cavities are opened and drained, and adhesions thoroughly separated. Drainage, preferably with gauze, completes the operation.

If such an operation is skilfully performed it is safer and shorter than by way of the abdomen, avoids the abdominal wound with its scar and tendency to hernia, and seldom fails to cure the patient. A suppurating hæmatocele or a phlegmon of the broad ligament resulting from a very early rupture may consist simply of a single cavity. Drainage may be established through a small opening posterior to the uterus, and, although the procedure is so slight as scarcely to deserve the title of operation, the result may be ideal.

The precautions essential to success in these vaginal incisions may be mentioned briefly as follows:

1. Make sure that the incision is sufficiently large to permit thorough drainage.

2. Make certain that no septic focus remains unexplored. A proper knowledge of the anatomy of the parts involved and reasonable tactile sense will enable the operator to avoid injury to important structures. In most instances it is less dangerous to open the free cavity and disengage all the adhesions possible, than to leave inflammatory masses untouched. Pay especial attention to the condition of the ovary on the supposed unaffected side.

3. Remove all blood and cleanse accessible soiled areas, but do not irrigate.

4. Do not use tubular drains, but drain the various infected regions with long narrow strips of gauze, drawn out like rope the size of a lead-pencil, bunching them together, and sufficient in number at the lower end to form a large drain, which will keep the vaginal opening stretched wide, and produce pressure on the vaginal and cellular vessels behind the cervix. The many bunched-up, small, rope-like strips of gauze are much less painful to remove than the larger gauze drains ordinarily employed.

5. Interfere with the patient as little as possible after the operation, keeping her in a semi-sitting (Fowler's) position the first three days. If symptoms do not demand a change, allow the first drain or packing to remain in place for six or eight days; then remove it carefully and replace it by four or five small pieces, making a drain the size of a large forefinger, which should be allowed to remain in place for four or five days. There will be a discharge for some time, but in three weeks fourteen out of fifteen of these patients will be practically cured.

Beware of treating a recent intraperitoneal or subperitoneal rupture by vaginal incision and drainage before sufficient time has elapsed to make it reasonably certain that the vessels are occluded, for in some such cases you will witness the most furious hemorrhage from a remote point which cannot be reached through a vaginal incision. In case of doubt it is best to operate through a suprapubic incision.

2. After the Fourth Month.

General Considerations. When an ectopic gestation has advanced well into and beyond the fifth month there are various considerations of importance bearing directly upon the safety of the mother which demand recognition and call for the greatest exercise of judgment on the part of the surgeon. The development of the sac, the increase in the size of the bloodvessels, the development of the placenta, and the probable presence of adhesions, all combine to increase the danger of interference very materially. As the gestation advances the whole mass does not present itself as a small lump around or on either side of which a ligature can be drawn and easy resection performed, but as a complicated condition presenting the most complex variations.

In cases at or near term the life of the child is a consideration of great importance. Although voluminous arguments have been advanced advocating interference while the child is living, no definite rule can be laid down on this subject, and the peculiarity of each individual case must be the guide to the course to pursue. It is justly held by most humane surgeons that the life of the child should be held subordinate to that of the mother, and that, if extra risks are to be encountered by the latter in order to save the infant, it must be clearly understood that the responsibility must not rest upon the physician managing the case.

When an advanced case comes under observation for the first time, say at the sixth month of gestation, shall the surgeon wait until the eighth month, and operate with the intention of saving the life of mother and child, or shall he operate at once, or shall he wait, as advised by some authorities, until spurious labor has occurred, that there may be less risk in the operation? These questions are most perplexing, but many patients present certain peculiarities or conditions that may aid us in reaching a conclusion.

The condition here existing is materially different from that arising where a Cæsarean operation is indicated, for in advanced ectopic gestation the danger to the mother is infinitely greater while the life of the child is of minimum value, as has been sufficiently proved by the researches of Harris, of Philadelphia.

A woman may be so reduced by repeated attacks of circumscribed peritonitis, recurrent moderate hemorrhages, and excessive pain that she can neither endure an operation nor continue in her present condition. In such a case, and there are such, the proper treatment is to resort to the old method; pick out some prominent fœtal part, either abdominally or vaginally; insert a hypodermic needle deeply into the part, with aseptic precautions, and inject sufficient morphia, say half a grain, to kill the child, but not enough to harm the mother. If the child dies, placental souffle will disappear, the pain will subside, some considerable part of the liquor amnii will be absorbed, the dyspnœa will become less, and no more hemorrhages will occur, and in three or four weeks an operation can easily be performed.

With a woman of strength and good health, with a child presenting favorably, and with a placenta that can apparently be easily avoided, the writer would advise endeavoring to save the child. At best, the dangers

are always great, and, unless all symptoms are most favorable, the infant life should be ignored.

Surgical interference in one way or another becomes necessary in almost all cases of advanced ectopic gestation, such interference being generally much safer than nature's efforts at relief. Patients with advanced ectopic gestation do not recover with ease without surgical aid, nor after careful analytical examination is the diagnosis usually obscure.

As the fœtal sac increases in dimensions the liability to sudden rupture, so characteristic in the earlier months, seldom occurs. The abdomen is more completely filled and the adhesions more complete, causing more pressure and leaving less and less free space for large hemorrhages.

Although the general diagnosis of ectopic gestation can usually be made with comparative ease, the difficulty of differentiating the variety becomes more difficult because of the occurrence of frequent small hemorrhages and the presence of irregularly situated masses of exudate, the result of localized peritonitis.

The object of all operations on ectopic gestation is the removal of the whole gestation sac, and this usually means removal of the affected tube in early cases. In advanced cases this is often impossible, but as the fœtus is the most offending part of the gestation it is always removed, and, as absorption of the placenta and sac is a slow and more or less dangerous process, they should also be removed when possible.

Hemorrhage is the greatest danger in these operations, and, therefore, avoidance of the placental site when practicable is of the utmost importance. This danger is almost entirely eliminated soon after the death of the child, and the most favorable time to operate is after that occurrence, but before definite signs of sepsis become manifest. Wait two or three weeks, if possible, until the placental souffle has ceased, but be ready to operate at the least indication of sepsis.

Because of this liability to hemorrhage, all these operations must be performed quickly and the parts brought well into view; therefore, in aseptic cases, which are those that bleed, when the child is supposed to be living, abdominal section is almost always the operation of choice.

When the child is dead and the placental souffle extinguished, it may occasionally be found advisable to operate per vaginam if the child is very superficially felt in the posterior cul-de-sac, and there appears to be no bar to extraction by that route because of the size of the fœtus. The cases in which this method is advisable are, however, extremely rare, the difficulty of reaching and properly detaching the placenta being greater by the vaginal route.

The vaginal incision will usually prove available only for the cases in which sepsis is well developed and the gestation sac is filled with putrid material and a decomposed fœtus, and presents in the vagina in such a manner as to form a clear indication.

The abdominal incision need not be median. The surgical sense of the operator must indicate the incision by which the fœtus can best be reached and the placenta avoided.

As removal of the fœtus is a matter of necessity, its location becomes a guide to the character of the operation. It must be remembered, however, that the exact site of the child and its relation to the peritoneum are frequently not determinable until after the incision is made, and

sometimes not even then, but nevertheless a proper understanding of the peculiarities of the different varieties of cases materially assists intelligent treatment.

(*a*) When the Fœtus is in the Unruptured Tube. If the gestation is of the infundibular variety there is great doubt whether it can ever develop so as to be included in the category of advanced unruptured tubal pregnancy. The very great majority, if not all, the cases are, therefore, ampullar or interstitial. In the latter variety the uterus has been dilated, its fundus cut through, and the child extracted. The proper and reasonable treatment, however, is simple abdominal section, made, if practicable, over the most prominent protuberance of the tumor, usually near the median line and low down. The external layer of the sac, or rather the tube, is often found adherent to the anterior wall of the abdomen, and the sac may frequently be freely opened without entering or even perceiving the free abdominal cavity. Every care should be taken to endeavor to avoid the placental site by careful and frequent auscultation before the operation, and by carefully deviating the inner incision, if possible.

The sac being opened, the child is at once extracted, and passed to an assistant, another assistant devoting his attention during this time to the compression of the broad ligament at each side of the sac. The upper border of this ligament on the affected side, if it can be isolated, may be ligated before the sac is opened.

The important step is the management of the placenta. If the child was living when the operation was begun, and the placenta was not materially injured during the operation, great surgical sagacity is needed to determine whether its extraction should be attempted. If it is conveniently situated and the surgeon has faith in his ability to control the blood-supply, it may be rapidly shelled out and a firm packing of gauze relied on to control the hemorrhage. If deeply attached and the large lower vessels are inaccessible because of adhesions, the placenta may be left in place and a firm gauze tampon relied on to check the flow of blood. If the child has been dead for a few days the placenta may be removed at once with only slight risk. No attempt should, as a rule, be made to remove the sac in this variety of cases. If the sac or uterus or both has been extensively lacerated, and hemorrhage seems uncontrollable, it is better to remove the uterus and sac together.

The edges of the incision in the sac should be sewed to the edges of the abdominal wound and the cavity packed with gauze, whether the placenta is removed or left in place. In the latter case, after a few days, the placenta can usually be removed with much less risk. If at any time, however, sepsis occurs, immediate removal of the placenta becomes imperative.

(*b*) When the Fœtus is in the Abdominal Cavity. These are usually, if not always, cases in which the gestation was originally tubal, and in which primary or secondary rupture into the free cavity took place so gradually that no very general hemorrhage occurred, and the fœtus simply lies in a sac formed of the chorion and amnion, which in time becomes attached indiscriminately to most of the adjoining structures. Removal of the sac with the placenta in this variety is very difficult, tedious, and dangerous. After the abdomen is opened a place

is found where the vessels are least numerous, the sac opened at this point and the child extracted. Unless the child has been dead some days, no attempt should be made to remove the placenta, which is usually deeply embedded in the pelvis at its original site. The sac is carefully packed with gauze, which is left protruding from the lower angle of the wound. The sac wound is attached, if possible, to the abdominal wound, and the abdominal wall closed down to the gauze at the lower angle. After a few days some of the stitches can be removed, and the placenta extracted, a new packing being carefully placed in the sac. If practicable, the ovarian artery should always be ligated on both sides of the mass.

In the case represented by Fig. 249 the author was enabled to shell out the sac in its entirety, the convalescence being thereby made as simple as the simplest of abdominal sections.

The abdomen should be bandaged rather snugly, excepting exactly opposite the drainage, lest removal of pressure provoke hemorrhage. In some cases the placenta may have spread out rather thinly over a great part of the anterior surface of the thin sac, and may be encountered above at almost all points.

If the child is small and packed down in the pelvis, and appears within easy reach by the vagina, it may in rare instances be extracted with more ease through a vaginal incision.

(*c*) When the Fœtus is Subperitoneal. The treatment differs but little from that of the varieties just described; but mention should be made here of two points: As the peritoneum is pushed upward and toward the unaffected side, the incision must be very low and often somewhat oblique, so as to reach the sac without entering the general cavity. The mass cannot be removed, because it is undefined, the membranes and peritoneum having become blended and fused together so as usually to obliterate even the semblance of a sac.

The operations just described are frequently extremely hazardous, and it is well to bear in mind that the primary object of interference is the removal of the fœtus. At this juncture the exact conditions of the patient must carefully but quickly be determined. If the operation is then proceeded with, it may be necessary at a moment's notice to leave the removal of the sac unfinished and trust to firm packing with gauze to control the hemorrhage. Some operators have simply tied off the umbilical cord as near the placenta as practicable and have closed both sac and abdominal wall without drainage, and with reasonable success, although the advent of sepsis renders early reopening and placental extraction necessary in the majority of cases.

When in an advanced ectopic gestation the fœtus is dead and symptoms of sepsis make it manifest that suppuration has occurred, the sac should be opened, all its contents removed, and drainage established. Whether this should be done through an abdominal or a vaginal incision depends upon the peculiarities of the individual case. Ordinary surgical sense must enable the operator to determine the easier route, for with due precautions regarding the rules of asepsis the easier method is generally the safer. The proper combination of the two may be advisable; for example, with a great deal of pus presenting plainly in the direction of the vagina, and a large fœtus, it may be better to make an incision below

and evacuate the most of the liquid contents, or have a competent assistant do this, and immediately open above and extract the child.

If pus has already found its way into the bladder, and the fœtus is much macerated, and already partially in the viscus, the latter may be opened from the vagina and the child extracted piecemeal. If the same accident has occurred by way of the rectum, the anus may be dilated and delivery be effected, or rather assisted, from that direction. Or vaginal or abdominal incision may be made if these other methods seem impracticable or too dangerous. Common sense and surgical ability point out the direction attended with the least risk.

When a patient formerly the victim of ectopic gestation comes under our observation only after the fœtus has become mummified or has undergone adipocere or calcareous formation, if the symptoms demand interference, the operative indications already presented as applying to a recently dead fœtus will suffice.

Repeated Ectopic Gestation.

A number of instances are recorded in which one tube having been removed for ectopic gestation, impregnation has occurred at a later date in the remaining tube, as has been determined by operation or autopsy. Several cases have also been reported in which undoubted proof has been furnished of two or even three consecutive gestations in the same tube. Uterine pregnancy in the presence of a retained fœtus, the result of a previous extra-uterine pregnancy, has frequently been noted. This may interfere mechanically with delivery, and its removal may become necessary.

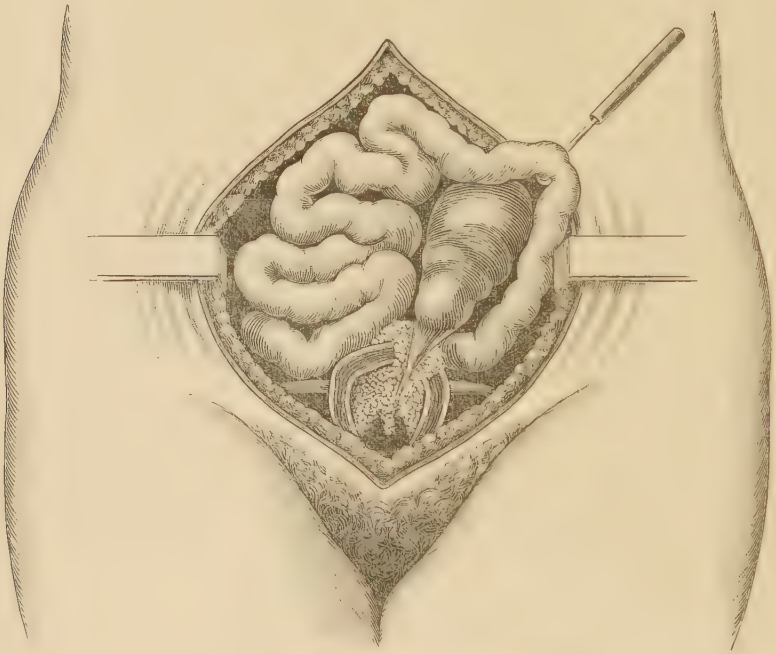
Twin Ectopic Gestation. These are very rare. Michin reports a case in which he operated by abdominal section and removed two embryos of equal size and age, each of which had its own separate fœtal membranes. This patient two years previously had been operated on by vaginal incision for left-sided tubal pregnancy. Twin ectopic gestations have been reported by Martin, Folet, LeDentu, and Barbot.

Concurrent Ectopic and Uterine Gestation. This condition is established when two ova, one in the uterus and one in a tube, become fertilized, either simultaneously or at different periods. The latter condition would be the result of super-fœtation. As a rule, concurrent ectopic and uterine gestation is an abnormal twin pregnancy and not the result of super-fœtation. The whole subject has been recently gone over by Weibel, who has collected 199 recorded cases. It occurs most frequently in women between twenty-five and twenty-nine years of age, that is, at the time when twin pregnancies in general are most common. Concurrent ectopic and uterine pregnancy may progress to full term, or either fœtus may prematurely perish. The treatment of such cases, when pregnancy is advanced, presents the most formidable condition known to the obstetric surgeon. There is no recorded instance of the survival of a mother after removal on the same day of two living children, at or near term, one being intra-uterine and the other extra-uterine. In only about one-fifth of the cases recorded did the development of both fœtuses progress to full term. The mortality in 111 cases reported by Weibel

was 36.04 per cent. The diagnosis is very difficult, even if two embryos are detected, generally the extra-uterine position of one not being suspected.

Treatment. Two courses may be followed : 1. As soon as the diagnosis has been established, the extra-uterine fœtus may be sacrificed. It is rare that the advanced extra-uterine fœtus cannot safely be reached with a fine exploring-needle. Sufficient morphin, say one-third to one-half a grain, may

FIG. 281.



Utero-abdominal or traumatic ectopic gestation.

in this way be injected into the body of the child, thus destroying its life without injuring the mother. Ten days or two weeks later, or at the slightest indication of sepsis, uterine contractions may be gently and carefully brought on, and a reasonable chance thereby be given to both the uterine child (if it be viable) and the mother. The extra-uterine fœtus can be dealt with later, according to the indications. Even if interference becomes necessary very soon after delivery, this secondary operation would be much more likely to be successful because of the probable elimination of abdominal hemorrhage, which is the predominant danger in all such cases.

2. Labor may be carefully induced and the ectopic gestation ignored and treated independently at a later period. A case was reported from Chrobak's Clinic in February, 1896, in which abdominal section was performed on a woman who had been delivered of her uterine child five days before, and a living child extracted from the abdomen. It was found necessary to remove the uterus with the gestation-sac. Mother and both children survived.

The general advice may be given: *Never operate on an advanced living ectopic gestation in the presence of an advanced living concurrent uterine pregnancy.*

Cornual Pregnancy. Arrest in the development or failure of coalescence of the Müllerian ducts in fœtal life may result in what is known as a bicornate uterus. When pregnancy occurs in one of the horns of such a uterus, the pregnancy may result in normal delivery, providing the horn is well developed. If, however, the horn is rudimentary and does not communicate freely and properly with the lower genital tract, we have a condition so closely resembling real ectopic gestation that it is usually described in the treatment of this subject.

The symptoms, course, and treatment of this condition require no further consideration than the statement that it is to all intents and purposes an ectopic gestation, presenting the same signs and requiring similar treatment.

Utero-abdominal or Traumatic Ectopic Gestation. A pregnant uterus may rupture, the fœtus may escape and develop in the abdominal cavity, the placenta retaining sufficient attachment to nourish the child. Leopold has reported such a case operated upon at term.

The following case came under the writer's observation in 1895: The patient, in the desire to terminate an existing pregnancy, introduced a sharp instrument into the uterus when about seven weeks pregnant. After two and a half months of intermittent suffering attended with subacute septic symptoms, an operation was performed which revealed the condition represented in Fig. 281. The fœtal sac still intact, about four or four and a half months advanced, was found in the free abdominal cavity, where it had been developing since the injury which caused its expulsion from the uterus. The placenta was still adherent to its original site, but had become attached to the uterine rent and to the adjoining external uterine surface.

CHAPTER XVIII.

DISEASES OF PREGNANCY.

The diseases caused by pregnancy itself and which tend to disappear after gestation has ended are to be differentiated from those conditions which complicate pregnancy, such as diseases of the pelvic organs, stomach, liver, and kidneys, which, although often presenting similar clinical pictures, are not included in the morbid phenomena that are here described.

Pregnancy by itself as a cause of disease is still imperfectly understood. One of the important obstacles to advance in our knowledge of this subject is the custom of regarding many of the minor ailments as physiological because of their frequency, as well as that of considering their etiology as differing from the graver manifestations. As a result, practically all the symptoms, if present without discoverable lesions of the organs which they represent, have been regarded as the expression of either a neurosis or a reflex irritation from the pregnant uterus, or some disease of the genital organs. Of recent writers, Williams still believes that such causes maintain in a portion of the cases, because of the absence of urinary changes and of the apparent success of suggestive therapeutics in selected instances.

THE TOXÆMIA OF PREGNANCY.

The term *toxæmia*, as applied to pregnancy, is used to express a common and toxic origin for a large number of symptoms and pathological processes that are now generally recognized as due to the pregnant state. However fragmentary, so far, may be the evidence upon which such a theory of their causation may be based, or whatever importance experience may lead one to attach to either the reflex or neurotic theories, recent experience has shown that the safety of the pregnant woman depends upon the therapeutical application of the principles which the toxic theory maintains.

The Evidence of Toxic Origin. 1. All of the symptoms, when occurring outside of pregnancy, are commonly regarded as expressions of toxic processes. 2. All of the minor manifestations frequently terminate in grave conditions which present the same clinical picture and anatomical lesions as those known to be due to definite poisons. 3. The urinary findings are often those generally recognized as being present in various toxic disturbances.

The Nature and Source of the Poison. We are entirely ignorant regarding both of these factors. Various theories have been proposed, none of

which, however, admit of exact demonstration. Even the experimental evidence that the blood is more toxic is not conclusive.

The *kidney theory*, based upon the frequent presence of albumin and casts in the urine, maintains that lesions of the kidneys cause a retention of poisonous products in the blood; but this fails to account for numerous cases in which no evidence of previous disease of these organs is found. Toxic symptoms also are hardly more frequent in those known to have been previously diseased.

The *fœtal theory*, whether the source of the poison, as suggested by Veit, is regarded as from the deportation into the general circulation of an abnormal number of syncytial elements, thus developing cytolysin and hemolytic changes, or from the transmission through the placenta to the mother of some retrograde products of albuminous metabolism, as suggested by Dienst, is not generally accepted.

The *ovarian theory*, as suggested particularly by Pierrehughes and Meillère, in which some abnormality of the ovarian secretion is supposed to produce the symptoms, is one of considerable theoretical interest. The occasional presence of similar symptoms during menstruation led Kehrer to believe that its cessation during pregnancy caused an accumulation of toxins in the blood.

The *intestinal theory*, as advocated by Dirmoser, that the disease is due to the absorption of toxic products from the intestinal canal, *whose* physiological chemistry and function are changed or destroyed from irritation of the pregnant uterus through the abdominal sympathetic, has, at least, furnished a rational method of treatment. Clinical experience also shows that in a large number of cases a disturbance of the intestinal function is the starting-point of the metabolic changes which are to be described in connection with the discussion of the next theory.

The *hepatic theory* is one in which it is assumed that a functional disturbancee of the liver starts a series of changes in the liver cells, so that intermediary products of metabolism are formed which act as poisons to the blood. Under such conditions the kidneys must eliminate all of these poisons, and they accordingly become so changed that the poisons are retained; or the kidneys may primarily become insufficient from the same poison as the liver, when the elimination ceases sooner than in the first case. Since the writer's publication in 1903, maintaining the toxic origin of that form known clinically as hyperemesis gravidarum, the hepatic origin of the toxic state in pregnancy has received prominent consideration. The proof of this theory so far rests upon the predominance of the liver lesions in the fatal cases, of the urinary changes that are often present, and upon the clinical relationship, as expressed by Williams, which acute yellow atrophy and allied diseases of the liver bear to pregnancy. It furnishes no evidence, however, of the primary nature or source of the poison. The idea that a fatty liver in pregnancy forms the anatomical basis for the functional disturbance is derived from observations of the livers of pregnant animals.

The *acid intoxication theory* rests upon the clinical course of a part of the cases and of the occasional presence in the urine of acetonuria, diacetic acid, and beta-oxybutyric acid. This theory, especially upheld by Painter, Sondern, and Baldwin, does not explain the origin of the process. The pathogenesis of acidosis in general is very imperfectly

understood, and in the present state of our knowledge cannot be considered as the basic factor in these disturbances.

The Pathological Anatomy.—As the milder forms end in recovery, no definite visceral lesions are known, but the inference that some changes in the liver are present seems justified from many of the clinical phenomena. According to Ewing, as the process is originally a functional disturbance, the intensity of the disease is not entirely dependent upon definite anatomical changes; even fatal cases occurring with apparent minimal lesions. In the fatal cases the most constant lesions are in the liver, which may differ in the clinical types; sometimes being that of a hemorrhagic hepatitis, as seen in eclampsia, or that of acute yellow atrophy, as shown in the figure for the type known as hyperemesis. The liver may be of normal size or it may be small. Its consistence may be soft; there may be few gross changes, but, microscopically, in all cases the evidence of the same process is plainly visible, namely, fatty degeneration and necrosis of liver cells. Ewing says the relation of these lesions to the loss of oxidative capacity of the liver cannot at present be fully explained. The anatomical lesions, he thinks, follow and do not precede the disturbance of function, and there may very well be several steps between the loss of oxidative capacity—the hydrolysis, fatty degeneration, and necrosis of the liver cells. The kidneys usually show considerable granular and fatty degeneration, which in exceptional instances may approach or even exceed those found in the liver. The changes in the kidney are secondary, as is shown by the fact that in some of the fatal cases with extensive necrosis in the liver the kidneys are practically normal, while extensive renal lesions are not seen without similar lesions of the liver.

Spleen and Other Organs. The spleen is often but not always increased in size, and is usually soft and dark colored. The gastro-intestinal tract, lungs, pancreas, and adrenals usually are normal or exhibit minor secondary changes. Dienst has called attention to fatty degeneration of the heart-muscle as a predisposing factor in preventing the elimination of the toxic products from the circulation. Multiple neuritis has been described by Lindemann, Eulenberg, and others, to which may doubtless be referred the occurrence of certain neuralgic pains, and from which the toxic theory has received additional support.

The Changes in the Urine. There may be no pathological changes in the urine that can be appreciated by the methods of examination that are available to the clinician, and in a few instances the more complete chemical examination of the laboratory may fail to detect any marked variations from the normal. The changes are apt to be more marked in the conditions in the latter part of pregnancy.

The *specific gravity* shows nothing characteristic, except that in the later months it is usually slightly lower. In most of the writer's cases in the early months there has practically been no deviation from the normal, even in severe cases.

Albuminuria in small amounts, at irregular intervals, has been regarded as physiological on account of its frequent presence without apparent unfavorable symptoms. The anatomical basis for this has been supposed to be the so-called pregnancy kidney, which has been described as a congestion from the pressure of the altered circulation. The safer

position is to assume that any amount of albumin is pathological, provided we have the assurance that it is not due to the admixture of discharges from the external genitals. Its clinical significance may be unimportant in some cases. The amount is generally small, not even appearing in some of the severest types until late in the disease. This may be true even in the later months in the form that terminates in eclampsia, in which it may suddenly appear as the attack begins. In such cases daily and even hourly examinations may be necessary.

Casts are less frequently present than albumin; when present they furnish additional evidence of possible danger, but hyaline and granular casts are frequently no more significant of an essential nephritis than is the albumin, which in these cases should be regarded as the expression of an acute degeneration.

Indicanuria. Inasmuch as no one believes that an intestinal toxemia is the initial factor in all cases, the absence of an increase of the indican in the urine may mean nothing. In the writer's experience, however, an increase in the indican has been present in most cases, and has seemed to furnish a rough clinical index of the presence of a toxæmia.

Acetonuria, Beta-oxybutyric and *Diacetic Acids* have been found in the urine by Sondern and Baldwin in some of the severe types of the disease, and when present are doubtless indicative of a severe intoxication. Their absence, on the other hand, gives no assurance of the safety of the patient. The same may be said of *lactic acid*, which Zweifel, in a very painstaking work, has found to be present.

Ratios of the Nitrogenous Substances. Reasoning from the pathological anatomy, Ewing, assisted by Wolf and Dreyfuss and aided by the clinical observations of Edgar and the writer, has thought that the metabolic disturbances of pregnancy should be expressed by some variations in the normal ratios of the nitrogen-containing elements in the urine. Accepting the recent work of Folin, which shows how much these ratios are modified by diet, it becomes necessary in order to draw proper conclusions, to observe the normal standards: The total nitrogen is found to vary from 3 to 15 grams *per diem*. Following this variation in the total nitrogen the percentages of the different substances correspond rather uniformly, as is shown in the following table, which gives the average percentage of three observations for each amount of total nitrogen (from table collated by Ewing and Wolf):

Total nitrogen elimination, grams . .	3	5	7	9	11	13	15
Percentage of total nitrogen:							
Eliminated as ammonia, grams . . .	12.2	6.2	5.5	5.2	3.4	3.7	3.2
Eliminated as urea, " . . .	64.2	75.0	79.0	80.0	83.0	85.0	87.0
Eliminated as kreatinin, " . . .	15.6	9.4	8.4	6.0	4.7	4.8	4.1
Eliminated as uric acid, " . . .	2.8	1.9	2.2	1.5	1.3	1.4	1.2
Eliminated as undetermined, grams .	8.9	8.4	6.6	6.2	7.4	5.7	4.7

Variations of two or three points above and below these figures are found.

In apparently normal pregnancies the ratios were found to correspond rather closely to this standard.

In the toxæmias the conclusions may be briefly stated as follows:

The *total nitrogen* shows nothing characteristic, except that in the vomiting type it is low, in some cases very low, due undoubtedly to the starvation.

The *urea-nitrogen* is distinctly lowered, although not always corresponding to the apparent severity as observed clinically. The clinical test for urea as determined by the ordinary hypobromite method is now known to be unreliable because other nitrogenous elements are included.

The *ammonia-nitrogen* is usually increased, occasionally very markedly, even reaching to an amount that is one-half or more of the total nitrogen. While these high percentages are usually associated with serious clinical states, they are not found to correspond closely enough to the different grades of the disease to use any definite percentage, as has been recommended by Williams, for a clinical guide in the treatment.

The *kreatinin* is often relatively increased.

The *undetermined nitrogens*, which include the *amino-acids*, are also increased in some cases very markedly, and usually more uniformly than the ammonia. As with the ammonia, however, it is not possible to use any definite percentage as a clinical guide to the treatment.

As a result of this work it may be stated, in general, that so far the metabolism of normal pregnancy, as expressed in the urinary changes, differs little from the non-pregnant state; but in the severe forms of toxæmia, at least, a review of the nitrogen distribution, expressed in relation to the total amount of nitrogen excreted, is considerably disturbed. To regard the variation of any one compound without considering the total amount of nitrogen will lead to false conclusions. While disturbances in these ratios are occasionally seen in cases that give no clinical symptoms, it is probable that the more general determination of these factors will show their practical value in diagnosis and treatment.

The Clinical Manifestations. The symptoms enumerated by Bouffe de St. Blaise show the possible clinical expressions of the toxic state:

1. Ordinary: Changes of disposition, lassitude, headache, vertigo, insomnia, neuritis, eye troubles, itching, ptyalism, dyspepsia, meteorism, constipation, bronzed tint of the skin, bleeding from the gums, urobilinuria, alimentary glycosuria.

2. Severe: Pigmentation of the skin, jaundice, albuminuria, general edema, hepatic pain, vomiting, delirium, convulsions. Some of these symptoms express conditions that have a definite clinical course.

The Vomiting of Pregnancy. Its frequency has been variously estimated. Giles, from a study of hospital cases, says that only 33 per cent. of women are entirely free from it throughout pregnancy. Williams thinks that it is present in slightly more than one-half of his private cases. The disease pursues different courses and may be either mild or severe.

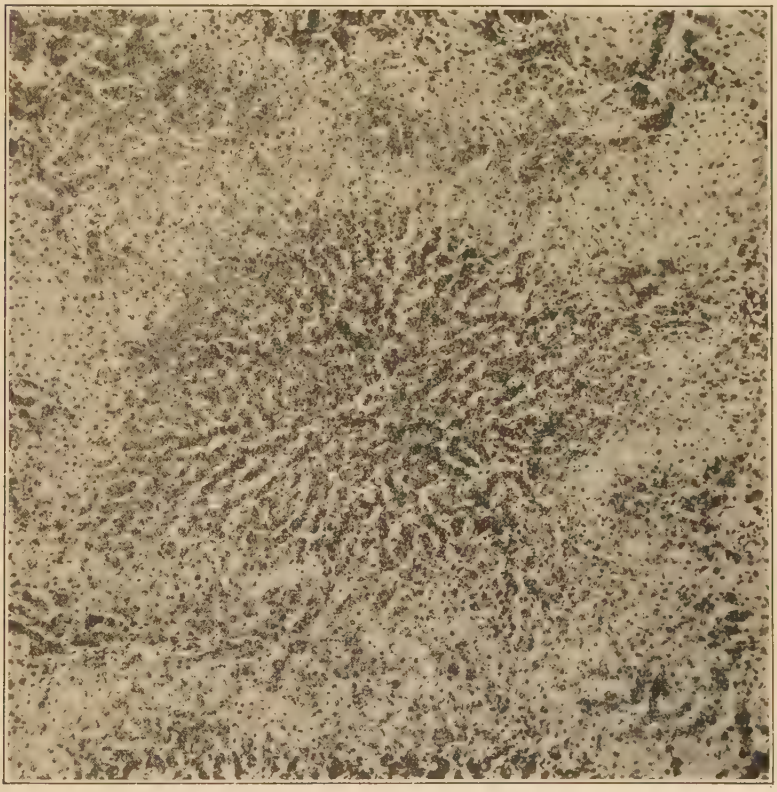
1. *Mild Types*, or the *ordinary vomiting of pregnancy*, usually begins early, sometimes apparently upon the day of conception, usually in the third or fourth week. The only disturbance may be nausea or vomiting upon first arising in the morning or immediately after breakfast, which does not recur during the day; or it may recur at infrequent intervals, but not often enough to interfere with nutrition or the general health. It frequently ceases abruptly in the fourth month and does not recur during the pregnancy. It occasionally continues in this mild form throughout pregnancy without interfering apparently with the health; but it should always be regarded with anxiety, because at any time a severe type may ensue or other serious manifestations of toxæmia may arise.

2. *The Severe Types, or the Pernicious Vomiting of Pregnancy.* Beginning as a mild form or immediately manifesting itself as the pernicious form, two general varieties are seen.

A. *The Acute or Fulminating Variety.* In this variety the vomiting within a few hours or days becomes almost continuous, is rapidly associated with prostration, rapid and feeble pulse, intense suffering, and is soon followed by delirium, coma, and death.

B. *The Subacute Variety.* It may begin as the mild type and the vomiting and prostration grow worse gradually, lasting for several weeks,

FIG. 282.



Liver of pernicious vomiting of pregnancy.

and finally terminating as does the fulminating variety in delirium, coma, and death. Frequently, however, the vomiting ceases abruptly, as with the mild type, and recovery rapidly ensues.

The character of the *vomitus* may be only a thin bile-stained fluid, which rapidly increases in amount, so that a pint or more may be vomited at one time. It finally becomes mixed with blood and is spoken of as black or coffee-ground. Other symptoms, such as ptyalism, jaundice, hepatic pain, and neuralgic pains in the legs, often accompany the condition.

The *prognosis* in the mild cases is good, but a severe form may always

ensue. In the cases classed as pernicious the prognosis is bad, especially in the acute type.

Ptyalism. An increase of the salivary secretion occasionally occurs, either alone or in association with other toxic symptoms, particularly vomiting, which in a case of the writer's caused more suffering than the vomiting. It usually begins in the early part of pregnancy and ceases in the middle period. A quart or more may be secreted in the twenty-four hours. It may be so severe as to demand an interruption of the pregnancy.

Gingivitis and Stomatitis may also be symptoms of a toxemia, gingivitis occurring, according to Pinard, in 60 per cent. of pregnancies, especially in those who are careless about the toilet of the mouth. Interstitial gingivitis, due to an auto-intoxication, as indicated in the urine and by the blood pressure, has been reported by Talbot.

Jaundice. This symptom may occur alone or in association with other toxic symptoms. Its presence should always be regarded as important at all periods of pregnancy as indicating some disturbance of the liver function. Its clinical importance is shown by the history of various epidemics of catarrhal jaundice that have occurred, in which pregnant women were found to be more susceptible and in whom it ran a much more fatal course than in men and non-pregnant women. This symptom may recur in several pregnancies. It should be remembered that the absence of this symptom in a severe type of toxæmia does not exclude severe hepatic lesions, for, as suggested by Croftan, the poison may have destroyed the bile function as well as the other hepatic functions.

Edema. This is a very common symptom during the last month of pregnancy, occurring, according to the writer's experience, in almost every case in the feet and ankles, and frequently in the hands, without other symptoms. Pressure from the gravid uterus can hardly account for its presence in the hands, and, like mild grades of albuminuria, it is best regarded as pathological, although not often followed by other symptoms. A general edema is one of the most common signs in the latter months of impending disaster.

Eye-symptoms. Disturbances of vision are very common expressions of a toxic process in the latter months of pregnancy. Sudden loss of vision, lasting for a few seconds or minutes, may occur at any period of pregnancy, but attacks which last for hours or days usually occur in the latter months, and are extremely important, not only as to their relations to eclampsia and other serious manifestations, but also on account of the possible permanent nature of the eye lesions. Loss of vision may be the only symptom present for weeks before other serious manifestations appear. After delivery the vision may improve or permanent blindness may result. The anatomical basis for these disturbances of vision has generally been regarded as the same as nephritis, but from some recent work of A. Knapp, Bauer, and others, it seems certain that the lesions are essentially different. Sometimes no changes are seen or there may be only an edema of the optic nerve. Most often there is an optic neuritis. In general, the changes are not permanent, except a severe neuritis, which commonly results in optic nerve atrophy. Meyer-Ruegg thinks that the examination of the eye may be of prognostic value in cases of eclampsia.

Skin Manifestations. The greatest variety of skin diseases is seen in pregnancy, most of which may be best regarded as expressions of a toxæmia. It is interesting to note that many of them are often seen during menstruation. Pruritus, urticaria, eczema, pemphigus, erythema multiforme, and impetigo have all been described in connection with pregnancy. Impetigo herpetiformis, which Hebra observed only in pregnancy, terminated fatally in 4 out of 4 cases. Herpes gestationis has been frequently observed. Stelwagon describes impetigo as a rare disease, often observed in pregnancy, in which the pregnancy is usually interrupted. An interesting lesion has been described by Brickner which he has called fibroma molluscum gravidarum. The writer has seen a marked example of this condition associated with all of the premonitory symptoms of eclampsia.

Pain. Headache is a very common symptom. In the latter months it has been ascribed to the presence of the cranial osteophytes, which we have seen, in connection with the normal changes of pregnancy, may be best regarded as of metabolic origin. Pains of a so-called neuralgic character are commonly present in various parts of the body. They may begin in the extremities as a feeling of numbness. Abdominal pains which are unaccounted for by the condition of the gastro-intestinal tract are also frequently observed. Paralyses occasionally follow pains localized in the extremities, and from the work of Winschied and von Rösslin it is probable that a neuritis followed by degeneration of the nerves is more common than is generally supposed.

Treatment. After all complicating diseases which might account for the manifestations have been excluded, the treatment of all the symptoms is essentially the same.

Prophylaxis is considered in the chapter dealing with the hygiene and management of pregnancy.

The Treatment of the Toxic State. Whatever theory is assumed as to the pathogenesis, the best therapeutic results are obtained from the correction of dietetic errors and from the adoption of those measures which are generally known to favor elimination through the intestinal tract, kidneys, and skin.

Dietetic measures often are all that is required in the mild forms. They should be adapted to the individual case, and the results will be much better if the physician prepares a written schedule for the patient to follow. In some cases it is a good plan to make a complete change of diet, however proper the customary diet seems to have been. In general, a diminution in the amount of proteids taken, as meat, substituting cereals, the lighter vegetables, fruits, and milk, will be found to give the best results. Tea and coffee should be stopped in almost every case. Over-eating is especially injurious. In the mild grades of nausea and vomiting it is extremely important not to allow the patient to indulge her own tastes for indigestible articles, which is often done because of the common notion that more or less vomiting is physiological. The dietetic treatment of this form is much more satisfactory than is generally supposed. It is often accomplished by instructing the patient to take several light meals through the day instead of the three ordinary ones. For this purpose milk, either plain or mixed with vichy, will materially aid in supplying the needs of the patient. Avoidance of excitement and insistence

upon the proper amount of rest also very materially aids in the treatment.

The *elimination of the toxic products* may be assisted by the adoption of the following plan: The ingestion of large quantities of water (either plain or aerated) between meals is very important. An early resort to catharsis, often in spite of the patient's protest that no constipation exists, gives brilliant results. Calomel in doses of one-half or one grain, taken at bed-time every third day for a period of ten days, followed by a saline in the morning, will often clear up symptoms whose etiology seems most obscure, unless their toxic origin is appreciated. Sufficient exercise and suitable bathing also aids in the elimination through the skin.

In the *severe types*, especially in *the pernicious vomiting*, absolute rest in bed should be insisted upon early in the course of the disease. Friends are also best entirely excluded from the patient's room. Drugs are of no value in the treatment of the vomiting. Everything must be prohibited by the stomach, except possibly water, which, by washing out the stomach, may aid in the elimination of the poison. Rectal alimentation should be resorted to early, at intervals of six or eight hours. Hot saline irrigation of the bowel for periods of ten to twenty minutes, two, three, or four times a day, are of the greatest value. If their administration is accompanied by too much discomfort, injection into the rectum of a pint of warm saline solution may be advantageously substituted. In desperate cases a dilution of the poison may be attempted by either hypodermoclysis or intravenous infusion. If no improvement follows this plan of treatment the advisability of terminating the pregnancy must be considered. There is unfortunately no symptom that affords a reliable index as to when this shall be done. It is probable, however, that an earlier recourse to consultation than is customary will materially aid in the solution of this problem. It should be remembered that the condition may be so precarious that the extra demands upon the organism of operative interference may determine a fatal result. The method of emptying the uterus should depend not only upon the period of gestation, but also upon the patient's condition. So far as possible a method should be adopted that will not require the use of an anæsthetic, especially of chloroform, which recent literature suggests is particularly dangerous in the presence of a faulty metabolism.

DISORDERS OF CIRCULATION.

Many of the minor disorders described as due to a disturbance of metabolism may without doubt occasionally be the result of pressure from the gravid uterus and from the changed circulation incident to the pregnant state. Of these may be mentioned palpitation, syncope, dyspnœa, and edema of the feet and ankles. As due to these causes they amount to little more than discomfort and are of little clinical importance. Great care, however, is necessary in their observation, that they are not associated with essential pathological processes.

Their *treatment* is the same as in the non-pregnant state, using every means to discover any local cause.

Hemorrhoids and Varicose Veins. As these affections result mostly from mechanical pressure, they are most marked in the latter part of

pregnancy; the veins of the anal region, the lower extremities, and vulva are the vessels most often enlarged. Pre-existing varicose veins are made much worse and occasionally reach such size in the vulva and lower extremities as to require observation and treatment. This is usually accomplished by the application of a large pad to the vulva and by bandaging the extremities. Occasionally it is necessary to put the patient to bed. Palliative measures for the hemorrhoids, in the form of lotions and ointments such as are used in the non-pregnant state, are often required until the pregnancy has ended.

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PART VI.

PATHOLOGY OF LABOR.

CHAPTER XIX.

ANOMALIES OF THE MECHANISM.

Dystocia, or pathological labor, is the term applied to labor which, without artificial assistance, would be difficult or impossible, or would be attended with danger to mother or child. It is the opposite of *Eutocia*, which denotes normal labor terminating safely and easily without artificial aid.

Every case of labor is a mechanical problem in which the three main factors are (1) the expelling force, (2) the fœtus which is to be expelled, and (3) the resistance of the parturient canal, which must be overcome before delivery can be effected. When the expelling force is sufficient, and there is no disproportion between the fœtus and the maternal passages, labor proceeds normally. As the fœtus descends through the parturient canal more or less adaptation takes place; the presenting part moulds somewhat to the shape of the canal, while the maternal soft parts stretch and open out to make way for it, till finally it is expelled spontaneously, without serious damage to itself or to the mother. So long, then, as these three main factors are properly correlated, all goes well; but if their harmonious action be impaired, the normal mechanism of labor may be disturbed, and dystocia may be the result. The cause of the abnormal mechanism may be in any one of these three factors: the expelling force may be insufficient or excessive; the fœtus itself may be unusually large or small, may be in a faulty attitude or may present in an unfavorable position; the resistance of the maternal passages may be too great or too little. It is obvious, therefore, that in the management of a case of dystocia the recognition of the disturbing cause forms the basis of rational treatment, and should precede artificial assistance.

Dystocia may be most conveniently described, according to its causation, in three sections, as follows:

1. Anomalies of the expellent forces:
   (*a*) Excess—precipitate labor.
   (*b*) Deficiency—delayed or protracted labor—inertia uteri.
   (*c*) Spasm and irregularity—rigid os and cervix—tetanus uteri.
2. Anomalies of the passages:
   A. Hard parts—pelvic deformities.
      Influence on pregnancy and labor; frequency.

Diagnosis—From previous history and physical appearance.
From mechanism of labor.
From head moulding.
From physical examination—pelvimetry.
(*a*) External measurements.
(*b*) Internal measurements.
Classification:
Pelves—Normally proportioned, but abnormal in size.
With anomalies of size, shape, inclination.
With minor developmental peculiarities.
Antero-posteriorly contracted.
Obliquely contracted.
Transversely contracted.
Compressed.
Spondylolisthetic.
Distorted by injury, tumors, anchylosis of joints.
With deformities due to spinal curvature.
Individual forms particularly studied; relation to pregnancy and labor.

B. Soft parts:
Uterus—Developmental anomalies.
Atresia of cervix.
Rigidity of cervix.
Impaction of cervix.
Malposition.
Sacculation.
New growths.
Stenosis and rigidity of vulva and vagina.
Hæmatoma vulvæ.
Œdema vulvæ.
Labial abscess and cysts.
Conditions of intestines.
Conditions of bladder.
Tumors and swellings of various tissues.

3. Anomalies of the fœtus:
Malposition of the head.
Occipito-posterior cases.
Malpresentations:
Face, brow, pelvic, transverse.
Prolapse of the limbs.
Anomalies of fœtal development:
Shortness of cord.
Unduly ossified skull.
Large size of fœtus.
Death of fœtus.
Enlargement of head or body by disease.
Plural births.
Monstrosities.

1. ANOMALIES OF THE EXPELLENT FORCES.

(*a*) Excess—Precipitate Labor.

When uterine action is excessive the resistance of the maternal passages may be overcome violently or rapidly, and then labor is said to be *precipitate*. The posture of the patient has an important influence upon the course and termination of such cases. In the dorsal or lateral position the pains are rarely strong enough to end labor so rapidly as to cause serious damage; but if the patient happens to be standing, walking, sitting, or squatting, a single violent pain may suffice to force the child completely through the passages. It may fall to the floor and be injured; the cord may be torn asunder and the placenta may be dragged from its attachments, or, remaining adherent, may pull the uterus along with it, causing inversion. If the patient happens to be sitting in a privy or water-closet, the child may fall into the cesspit or into the pan of the closet, and may perish before assistance can be procured. Not infrequently the mother faints from shock or loss of blood, or she may become so bewildered and frightened that she does not realize what has happened until it is too late to save her child. Such cases sometimes give rise to important medico-legal questions, especially when the child is illegitimate and a charge of infanticide is laid. While undoubtedly it must be admitted that such cases of sudden delivery do happen occasionally, *nevertheless it is very exceptional* for labor to be so rapid that the patient has no warning of what is about to take place and has no time to seek assistance. As a rule, the first stage of labor is more or less normal in such cases, and it is only in the second stage that precipitancy occurs. If the membranes are tough and the amniotic sac descends very low before rupturing, then the sudden gush of water may sweep the presenting part violently down upon the perineum, and delivery may be completed at a single pain. It does not always happen that precipitate labor follows excessive uterine action. If the maternal soft parts do not yield to the expellent forces, but are rather provoked thereby to greater resistance, labor may be delayed, and the uterus may become exhausted by fruitless efforts, or may even rupture. Under such circumstances the child will probably perish, the placenta being compressed and the fœtal circulation deranged by the prolonged uterine contraction.

Causes. The chief predisposing causes are (1) an undue excitabilty of the sensory nerves of the uterine muscle, which frequently exists in nervous excitable women,[1] and (2) previous inflammatory conditions of the uterus, such as an old endometritis. Debilitating conditions which relax the tone of the pelvic floor favor precipitate labor by diminishing the resistance which is to be overcome. Dysmenorrhœa, oblique presentations, pneumonia, and zymotic diseases (especially variola and scarlatina),

[1] Dr. Routh recently reported to the London Obstetrical Society a case of labor in a woman suffering from complete paraplegia (traumatic) below the level of the sixth dorsal vertebra. The only sensation which the patient felt during a pain was a tight feeling at the epigastrium, causing her to hold her breath. Dr. Routh concludes that the act of parturition is partly automatic and partly reflex, and thinks that direct communication by means of the sympathetic between the uterus and the lumbar enlargement is essential to the regular and co-ordinate contraction and retraction of the uterus during labor. If this view be correct, it is obvious how powerfully uterine action may be influenced by causes acting through the sympathetic, and how frequently the true cause of abnormal uterine action may be found in derangements of the nervous system.

may be mentioned also as predisposing causes. Fear, anxiety, and powerful emotions are said to increase the force of uterine contractions, but it is probable that their action is not constant, and that undue exertion on the part of the patient, such as walking, is usually the exciting cause. It sometimes happens that diminished resistance of the soft parts is the chief cause of precipitate labor or favors its occurrence. When the child is very small, or when the parturient canal is overlarge or relaxed, or when its resisting power is impaired by old lacerations from previous confinements or by nervous influences or other physical conditions, precipitate labor may occur. It is more common in multiparæ than in primiparæ; in the latter it must be regarded as very exceptional.

Sequelæ. The most important immediate consequences of precipitate labor are lacerations of the placenta, hemorrhage, inversion of the uterus, syncope from sudden relaxation of intra-abdominal tension, and delayed expulsion of the placenta. Violent contraction of the uterine muscle is apt to be followed by relaxation and atony, and hemorrhage may result. In the puerperium also many troubles may arise, such as œdema, retention of the placenta, hemorrhage, and septicæmia. Violent straining efforts in rare cases have produced emphysema of the throat, neck, and chest from slight lesions of the trachea or bronchi; but this usually disappears in a few days without treatment.

The fœtal mortality is greater than in normal labor. The child's head may be injured by being driven forcibly against the promontory of the sacrum, and the cranial bones may be furrowed or even fractured. The child may be asphyxiated by undue compression of the fœtal head or of the cord or placental site. It may be injured by falling violently upon the floor, or it may perish by dropping into a cesspit or water-closet.

Treatment. If a previous labor has been precipitate, or if the uterine action is manifestly excessive or violent, the patient should not be allowed to stand or walk about, or to sit upon the closet, especially during the second stage of labor, but should be kept in bed and made to lie on her side. To moderate the violence of the pains, a dose of chloral (grs. xx to xxx) may be given, or a hypodermic injection of morphia (gr. $\frac{1}{4}$), or a few whiffs of chloroform may be administered at the beginning of each pain. The patient should be made to pant during her pains, and should not be allowed to hold her breath or bear down. Some authorities advise rupturing the membranes before the os is fully dilated. When the pains of the first stage cause great suffering, some writers recommend painting the cervix with a solution of cocaine (4–10 per cent.). During delivery care should be taken to protect the perineum, the head being held back and prevented from descending too rapidly. Certain authorities advise the application of forceps in order to give greater control over the head and prevent its too rapid descent and expulsion. Chloroform is invaluable at this stage. Great care should be taken in the management of the third stage of labor; plenty of time should be given for the placenta to separate, and the uterus should be kept under control for some time after the placenta has been expelled, in order to guard against subsequent relaxation. If the uterus does not contract well, or if it shows a tendency to relax, a copious hot intra-uterine douche should be given, followed by a hypodermic injection of ergot. The

physician should not leave his patient until he is satisfied that the uterus is well contracted, and that there is no further danger of hemorrhage.

(*b*) Deficiency—Delayed or Protracted Labor—Inertia Uteri.

When the uterine action is insufficient to overcome the resistance of the parturient canal, labor is delayed and the pains are said to be *weak* or *inefficient*. The weakness of labor-pains is relative. Pains which would be strong enough for the first stage may be inadequate for the second stage. Pains which would be normal and efficient if the resistance were slight, may be inadequate and, therefore, abnormal when the resistance is great. The true test of the weakness and inefficiency of labor-pains on the one hand, or of their strength and efficiency on the other, is the advance of labor; whenever they are too short or too feeble to secure the normal progress of labor, they are *weak*. Mere sluggishness of uterine action, however, is not to be confounded with weakness. Sluggish pains recur at abnormally long intervals, yet they may be strong and efficient nevertheless. In estimating the character of the pains three qualities should be considered: (1) Their *length*, (2) their *strength*, and (3) their *frequency*.

Causes. The cause of deficient uterine action may be either in the uterus itself or in some other organ. There may be some congenital malformation, as the uterus bicornis, or the uterine muscle may be imperfectly developed or may have been weakened by previous inflammation, by menorrhagia, by repeated abortions, or by too frequent child-bearing. Its fibres may be so stretched that they cannot contract efficiently, as in multiple gestation or hydramnios. There may be malpresentation, too early rupture of the membranes, or a faulty attachment of the placenta, as in placenta prævia. New growths in the uterine wall, as myomata; displacements of the uterus, as prolapsus; or deviations in its axis, may all cause inertia. Uterine weakness in the third stage frequently occurs in precipitate labor; and, on the other hand, it is very likely to follow a prolonged and painful first and second stage.

Very often the cause of weak uterine action must be sought elsewhere. A distended bladder or rectum, a dilated stomach or intestine, may so alter the position and axis of the uterus as to make its contractions painful and inefficient. Sometimes the patient does not use her abdominal muscles properly and the uterus is unable to overcome the resistance of the parturient canal unaided; or the abdominal muscles may have been weakened by too frequent child-bearing or by separation of the recti muscles. The physical strength of a patient is not always a correct index of the expulsive power of her uterus or of the ease of her labor; much depends upon her fortitude and pluck and the intelligent use of her voluntary muscles. Weak and delicate women (*e. g.*, consumptives) frequently have strong pains and easy labors, while robust, powerful women are often disappointing by reason of their weak pains and tedious labors.

Long residence in tropical climates tends to cause uterine inertia. European women in India suffer from menorrhagia, uterine inertia, and post-partum hemorrhage. A luxurious and enervating life predisposes

to inertia. Age has also a certain influence; in young primiparæ the pains are apt to be imperfect and irregular. Mental conditions, such as grief, excitement, and depression, often weaken the force of uterine contractions. Malnutrition, exhaustion from intercurrent diseases, and excessive or prolonged vomiting predispose to inertia.

Symptoms. The symptoms depend upon the stage of labor. If the membranes are unruptured and weakness manifests itself during the first stage, the pains become short, irregular, infrequent or cramp-like, the cervix dilates very slowly, the bag of membranes does not feel tense or press down into the cervix during a contraction, the presenting part descends but slightly with each pain, and may be pushed back easily with the examining finger. If the membranes rupture early, the presenting part advances slowly or not at all. The chief indication, therefore, of deficient uterine action in the first stage is delay or arrest of labor from imperfect dilation of the cervix. Constitutional symptoms (elevation of temperature, pulse, and respiration) do not usually appear unless the delay is very prolonged. In the second stage the symptoms are chiefly those of pressure. If the presenting part is arrested but not impacted, the pressure symptoms may not be pronounced; but if impaction occur, the vagina soon becomes hot, dry, swollen, and tender, the external genitals swell, and there may be cramps in the legs and cutting pains in the back, loins, and abdomen. If impaction is allowed to continue, sloughing of the soft parts may supervene. After a time constitutional symptoms develop, the pulse, temperature, and respirations rise, the tongue becomes furred and dry, nausea and vomiting may occur, the countenance becomes anxious, the face swollen, the patient restless, and if she be not promptly relieved, low muttering delirium supervenes and death ensues with symptoms of profound exhaustion. It is remarkable with what rapidity nervous exhaustion takes place when strong uterine contractions are unable to overcome the resistance of the birth-canal. The fœtus, too, shows signs of distress; its movements become violent, the fœtal heart-beat increases and then rapidly decreases in frequency, and finally death occurs from asphyxia.

Sometimes the uterine weakness is not general, but is confined to the fundus, the placental site, or a portion of the anterior or posterior wall. If the weakness is in the fundus, labor is usually slow; if in the anterior or posterior wall, the weakened portion bulges, and rupture may take place; if near the placental site, there may be deficient contraction and retraction during the third stage, and the placenta may be retained, or hemorrhage may occur.

Care should be taken to distinguish between a powerless uterus and a tetanically contracted uterus. In both cases labor is arrested or delayed, but in the latter case the condition is more serious. The uterus retracting about the fœtus becomes unevenly pressed about the limbs and body of the child, and certain portions of its walls becoming intensely congested and thinned out may rupture or slough subsequently. The tetanic uterus is known by its constantly hard and board-like feel; such a condition should not be ascribed to inertia uteri.

The effects of deficient uterine action upon the third stage of labor are important. The uterus may have acted well during the first and second stages, but may have become so exhausted that it cannot contract and retract satisfactorily during the third stage. Occasionally the weakness

in the third stage is only the continuation of weakness in the first and second stages. Good uterine contraction is essential to the proper separation and expulsion of the placenta; hence when the pains are infrequent and weak, the placenta is apt to remain partially or wholly adherent, and in the former case hemorrhage occurs. After separation has taken place a weak uterus may be unable to expel the placenta and membranes from its cavity, and even after they have come away it may tend to relax and permit free hemorrhage or the formation of a large clot.

Diagnosis. The diagnosis is made by making a vaginal examination during a pain and by palpating the abdomen externally. In the first stage of labor, if the bag of membranes does not become tense, and the presenting part does not descend during a pain, if the cervix does not dilate and labor does not advance, the uterine action is inefficient. If in the second stage the presenting part becomes arrested or impacted, if the maternal passages become dry, swollen, and tender, and especially if constitutional symptoms supervene, it is safe to conclude that the expellant forces are unable to overcome the resistance of the parturient canal. By palpating the abdomen it may be ascertained how frequent and strong the pains are, and whether there is any deviation in the axis of the uterus, or whether a distended bladder is interfering with uterine action. In doubtful cases the condition of the thoracic and abdominal viscera should be ascertained.

Prognosis. The prognosis depends upon the stage of labor, the degree of weakness and its cause. In the first stage, if the membranes are unruptured there is usually very little danger for either mother or child; but if the membranes have been long ruptured the life of the fœtus may be imperilled. In the second stage there may be danger for mother and child if labor be too much prolonged. According to some authorities, delivery cannot be delayed safely beyond seven or eight hours after rupture of the membranes. No such hard-and-fast rule can be laid down, since in some cases a long delay may be harmless, while in others a comparatively short delay may entail serious consequences. The condition of the mother and child should be watched carefully in all cases of delayed labor. A slowing fœtal heart foreshadows danger to the child, while local œdema and a rising pulse and temperature are maternal danger-signals which should not be disregarded. As a general rule, the longer the delay the worse is the prognosis for both mother and child. The prognosis is usually better in multiparæ than in primiparæ, and better in partial than in total uterine weakness. Atony of the placental site and general atony of the uterus in the third stage are serious conditions, for they may lead to violent or uncontrollable hemorrhage.

Treatment. The treatment varies according to the stage of labor, the cause of inertia and its extent. The room should be kept cool, since heat favors uterine weakness. Visitors should be excluded and the patient kept free from excitement. If the cause of inertia can be ascertained, it should be removed if possible; a distended bladder or rectum should be emptied, a deflected uterine axis straightened. In the first stage of labor, if the membranes are unruptured and the patient is exhausted, no attempt should be made to excite uterine action, but rest and sleep should be secured by means of chloral, grs. xx, repeated if necessary, or a hypodermic of morphia, gr. $\frac{1}{8}$ to $\frac{1}{4}$. Chloral is generally

preferable to morphia, because it does not arrest the progress of labor. Opium is apt to stop or weaken the pains, and should be used only when the suffering is too great to be relieved by chloral. Chloral and opium may be combined sometimes with advantage; a very good draught is:

Chloral. hydrat.	gr. xx;
Liq. op. sed. (Battley)	℥x;
Syr. aurant.	ʒij;
Aq. ad.	ʒj.—M.

Antipyrine is sometimes useful when the pain is mainly neuralgic in character. At the same time broth, hot milk, gruel, or some other nutritious assimilable food should be given to maintain the patient's strength. After a few hours' rest strong uterine action generally sets in and labor proceeds normally. If the membranes have long been ruptured and further delay seems inadvisable or dangerous, coffee, broth, or eggnog may be administered, and attempts made to increase the power of uterine contractions. Quinine is sometimes of great value, but it must be given in large doses to be effectual—not less than fifteen grains should be given in two powders or cachets within the space of half an hour; if the stomach is irritable, quinine may be given in rectal suppository (gr. xx to xxx). Strychnine hypodermically (gr. $\frac{1}{30}$ to $\frac{1}{20}$) is very often useful, especially if the heart action is weak. Locally, a copious hot vaginal douche (3 to 4 quarts of boiled water at a temperature of 105° to 110° F.) may be given every hour or two. Good results have been reported from the introduction of a soft bougie into the uterus, as in Krause's method of inducing labor. On the Continent a favorite method is to pass a rubber bag (colpeurynter) into the vagina and then distend it slowly with water or air. The Champetier de Ribes bag, introduced into the uterus, is very useful for this purpose, and sometimes changes the character of the pains remarkably. Hot fomentations to the fundus are employed sometimes to excite or increase uterine action; or hot and cold applications may be alternated.

It is the custom with some practitioners to rupture the membranes early in the first stages of labor for the purpose of hastening delivery. Such practice is not only harmful, but actually tends to prolong rather than shorten labor, especially when uterine action inclines to be weak. As a rule the membranes should be preserved intact as long as possible, or at least until dilation of the cervix is nearly complete. When, however, the uterus is overdistended, as in hydramnios, and the contractions are weakened thereby, it is advisable to rupture the membranes, even though the os is only partially dilated, in order that the tension may be relieved and uterine action stimulated.

If, however, the os is fully dilated or nearly so, the membranes are unruptured, and the pains inefficient, the cause of delay may be the unusual toughness of the membranes. In such a case the membranes should be punctured, and then labor will go on naturally. Occasionally, too, adhesions between the membranes and the lower uterine segment resulting from endometritis may prevent the normal mechanism of dilation. An attempt should be made to separate the adhesions by means of the finger swept gently around between the uterine wall and the membranes; if that manœuver fails, or if it requires too much force, it is

advisable to rupture the membranes and allow the head to come down upon the cervix, when dilation will usually proceed without further difficulty.

In the second stage, when further delay is likely to be injurious, labor should be terminated as soon as possible. When delay is due to weak muscular action, or to some deviation in the uterine axis, a change of posture often produces the happiest results. If there is excessive right obliquity the patient should be made to lie on the left side; if there is anteversion from lax abdominal walls, a binder should be applied and the patient should lie on the back. Sometimes uterine action may be stimulated very satisfactorily by changing the patient from the lateral to the dorsal position and raising the shoulders till she is sitting almost upright, or by causing her to get out of bed and walk about, or stand or sit for a time.

Manual pressure applied to the fundus through the abdominal wall is a valuable means of intensifying feeble pains and prolonging their efficiency. The patient should lie in the dorsal position, and pressure should be made during a pain in the axis of the brim, much in the same way as in the Credé method of expressing the placenta. Schmidt, of Moscow, places the patient in the extreme lithotomy position during this manipulation. Roughness should be avoided, and care should be taken not to compress or injure the ovaries.

Recently the use of ergot has been warmly recommended to increase the force of the pains in the second stage of labor. It is possible that such practice may be serviceable in exceptional cases, but ergot is more or less dangerous before the birth of the child, and its use cannot be recommended unless for some special indication. It should be given cautiously, a dose of ♏x to xv of the fluid extract hourly for two or three hours usually being sufficient.

Operative interference (forceps, version, etc.) may be required to terminate labor. No doubt much harm may be done by the rash and indiscriminate use of forceps; but it is possible to err in the other extreme; indeed, it is quite likely that more lives have been lost and more serious injury has been done by deferring the use of forceps too long in lingering labor than by operating too early.

When a multipara gives the history of uterine inertia in a previous labor, it is well to give strychnine as a prophylactic during the last four to six weeks of her pregnancy, very much in the same way as it is given to guard against hemorrhage in those who are predisposed to it. It should be given in doses of gr. $\frac{1}{60}$ three times daily, and may be increased to gr. $\frac{1}{30}$ during the last week.

(*c*) Spasm and Irregularity—Rigid Os and Cervix—Tetanus Uteri.

The uterine contractions may be abnormally painful, and whether strong or weak they may be faulty in direction, duration, or effect. Such spasmodic contractions may be general or partial, and although clonic at first, they soon tend to become tonic. The so-called tetanus uteri is a condition of general tonic contraction.

Causes. A uterus rendered irritable by previous endometritis may take on spasmodic action after premature rupture of the membranes, especially if there is malpresentation or impaction, or if there is undue resist-

ance, as in pelvic deformity. The tendency to spasmodic action is increased by too early use of ergot, by repeated vaginal examinations, or by rough manipulations, as in attempts to dilate the cervix forcibly or to deliver by forceps or version through a partially dilated cervix. In the third stage of labor, attempts to deliver the placenta by traction upon the cord may cause a similar condition. When the spasmodic action does not involve the whole uterus the structures most commonly affected are the circular fibres around the external and internal os and the orifices of the Fallopain tubes, and then a sort of spasmodic stricture is produced. Stricture and tetanus uteri differ only in degree; the former readily passes into the latter, followed by marked constitutional disturbance, if the spasm be not promptly relieved. Spasmodic contraction of the internal os may delay labor; a similar effect may be produced by the undue contraction of Bandl's ring (contraction-ring), commonly called *hour-glass contraction* of the uterus.[1] The disturbances in the course of labor caused by this spasmodic constriction vary according to the position of the fœtus in utero, the degree of uterine activity, and the amount of constriction caused by the ring. The constricting fibres prevent the descent of the fœtal parts which are above them into the lower uterine segment, and this holding back of the fœtus prevents the advance of the parts which are already below the ring. As a result of this obstacle to descent the progress of labor is retarded or arrested altogether.

Diagnosis. If the fibres of the os and cervix are chiefly involved, the os is sensitive to touch and feels to the examining finger like a tensely stretched ring; it may remain unchanged for hours in spite of strong uterine action. The rigid os caused by spasmodic action is sometimes called the *whip-cord* os; it is usually found in nervous women. The *œdematous* os is caused by prolonged pressure of the hard head against an imperfectly dilated os. It occurs generally after too early rupture of the membranes. These forms of rigid os must be distinguished from the *cartilaginous* os, which is caused by an excessive amount of fibrous tissue in the cervix and os. This is found in women with masculine pelves, or with procidentia uteri, friction causing an increase of fibrous tissue. In addition to these varieties of rigid os, the cicatricial os, with its tough, unyielding scar tissue, must be borne in mind—cauterizations and operations for repair of lacerated cervix are the commonest causes. In dystocia from rigidity of the os the lower uterine segment and the cervix may thin out and become stretched over the presenting part, yet the os does not yield. When there is general tonic spasm the uterus does not relax, but remains in a state of continuous contraction, and through the abdominal wall feels as hard as a board. If it becomes moulded about the head, elbows, and knees of the fœtus, and assumes an irregular contour, the fœtus is held gripped in the spasmodic clutch of the uterine fibres and labor is arrested. Tumors of the cervix, benign or malignant, may cause dystocia and may require surgical interference.

Prognosis. The prognosis is more favorable for mother and child in stricture than in tetanus uteri. In the latter the placental circulation is seriously disturbed and the child is apt to perish soon from asphyxia. After a time the uterus becomes so unevenly thinned and stretched that

[1] Some writers maintain that hour-glass contraction is caused by the spasmodic contraction of a band of circular fibres in the uterine body above the level of Bandl's ring.

it is likely to rupture or to be injured and lacerated during attempts to effect delivery.

Treatment. Whenever spasmodic action of the uterus exists, even in slight degree, frequent vaginal examinations and rough manipulations should be avoided and ergot should not be given. In mild cases and in the early stages generally, spasm may be relieved by the internal administration of chloral (gr. xx, not more than three doses being given), or by a hypodermic injection of morphia. Locally much relief is obtained by a hot sitz bath and copious hot vaginal douches. If these measures fail, chloroform should be administered at once and continued till spasm is relieved. Unless in cases of extreme urgency, delivery by forceps or version should not be attempted until the os has become well dilated and uterine spasm has relaxed, otherwise so much force may be required to effect delivery that serious injury may be done to both mother and child. If the os is rigid and operation is urgently demanded, manual dilation under chloroform should be tried, or a Champetier de Ribes bag may be used; if these measures fail, multiple incisions should be made in the os. When the child is dead, or cannot be delivered alive, embryotomy should be performed. In extreme cases Cæsarean section may be required. Under no circumstances is it wise to resort to *accouchement forcé* in such cases. Under proper management, tetanus uteri should not be allowed to develop. Even after delivery has been effected all danger is not over: the placenta may be retained and the patient may require to be deeply anæsthetized before it can be extracted; severe bruising and laceration may have taken place, and the patient may suffer subsequently from pressure-fistulæ, pelvic exudations and inflammations, or from septicæmia.

Some obstetricians report considerable success in the treatment of rigid os with the use of cocaine and atropine. The os is painted with a 2–4 per cent. solution of cocaine, or a cocaine suppository is placed in the cervical canal, or a hypodermic injection of atropine (gr. $\frac{1}{40}$) is made into the rigid cervix.

Some writers describe a variety of cervical spasm in which the cervix contracts tightly about the neck of the child after the head has passed. This condition, however, seems to be an elastic rather than a spasmodic contraction of the cervix, which continues if the shoulders are very large and the uterus is lacking in expulsive power. In most cases it may be overcome readily by stretching the contracting ring with the fingers while strong downward pressure is made upon the fundus.

In breech cases, too, the cervix may contract about the neck and prevent the descent and delivery of the head.

If the child is alive, too much time should not be wasted in attempts at natural extraction, but forceps should be applied promptly to the after-coming head, the forceps blades dilate the contracted cervix, and delivery is usually effected without much difficulty.

In all cases of dystocia from rigidity of the os and cervix, it is of the utmost importance to determine whether the rigidity is spasmodic or organic. If the former, active intervention is seldom required; if the latter, delivery can seldom be effected without it. It is also important to recognize the condition early, and by the use of judicious treatment prevent the occurrence of tetanic contraction.

CHAPTER XX.

ANOMALIES OF THE MECHANISM.—Continued.

2. ANOMALIES OF THE PASSAGES.

A. Hard Parts—Pelvic Deformities.

Under this heading are included all variations from the normal type of bony pelvis. The great majority of these anomalies are of the nature of contractions, which make labor a difficult or dangerous process for the mother, the child, or for both, and which generally call for some form of artificial delivery. The pelvis may be contracted in any or all of its diameters, but as the most serious forms are those in which the brim is affected, it is very common to use the term "contracted" as referring to these alone. In such a sense it is employed in this chapter, unless otherwise indicated.

Contracted pelves may influence the position of the uterus during pregnancy. Thus, in the early months marked contraction of the pelvic inlet may cause the growing organ to become retroverted, a condition which may be followed by incarceration in the pelvis. In the late months the uterus is higher than normal, the fœtal head not being able to sink within the pelvic cavity. The abdomen is rendered unduly prominent; pendulous belly is often marked; the long axis of the uterus being directed forward or to one or the other side.

Contracted pelves also influence the presentation and position of the fœtus, malpresentations and malpositions being about three times as frequent as in normal pelves. Thus a vertex presentation may be changed to a brow, face, or transverse. When the breech presents the knees or feet are apt to descend. The cord is also apt to prolapse into the lower pole of the uterus. These malconditions are favored by multiparity, owing to the increased relaxation of the uterine and abdominal walls.

But it is in labor that the most marked effects of contracted pelves are seen. At the beginning of the first stage the presenting part is higher than in the normal condition, and it does not fit well into the lower pole of the uterus. The cervix and lower uterine segment hang loosely at or above the brim. The liquor amnii is driven downward, and there is a tendency to the protrusion of the bag of membranes through the slowly dilating cervix as a sausage-shaped mass. Frequently the bag ruptures early, the uterus being drained of the liquor amnii. If the contraction be not too great to allow the fœtus to be born, labor may continue, being prolonged and painful, the cervix dilating slowly, and the fœtus born dead, the head being much altered by moulding, sometimes with fractures of its bones. If the labor be too prolonged in such a case, or if the contraction be too great to allow the fœtus to descend at all, the mother may become completely exhausted, and labor may cease for a time, or excessive thinning and stretching of the lower uterine segment may continue until it ruptures, alone or along with the cervix and vaginal wall; sometimes the uterus may be torn from the vagina.

In any case there is apt to be bruising of the soft parts from prolonged pressure of the head, and this may be followed by sloughing.

It is thus evident that the risks to the mother are varied and serious. The life of the fœtus is also greatly endangered, owing to pressure on the head, prolapse of the cord, delay in delivery, or to complications arising from operative measures necessary to the extraction of the fœtus.

Frequency. Deformed pelves are generally considered to be much more frequent in the Old World than in the New. In the light of recent work it is doubtful if this widely held view is correct. In both continents it is very difficult to get accurate data regarding the frequency of their occurrence. This is due to the fact that there is an absence of a common understanding regarding the definition of deformity. Thus, both in Europe and America, many observers have neglected minor degrees of contraction, considering only those capable of causing serious troubles. Statistics vary also according to the expertness or fitness of different observers in recognizing deformities.

In this connection the recent work of Williams and Dobbin, of Johns Hopkins, is worthy of the most careful study. Their observations are a direct challenge to those who hold the common belief regarding the infrequency of pelvic deformity in America. It is their view that deformities are considered rare only because they are not systematically looked for by the routine examination and measurement of all pregnant and parturient women. In 1000 cases of labor observed by them there were 131 contracted pelves, or 13.10 per cent. Of this number, 46, or 35.11 per cent., were of such a degree as to necessitate operative delivery. It is interesting to compare these figures with those of Winckel, who states that 10 to 15 per cent. of all childbearing German women have contracted pelves, but that only in 5 per cent. is the contraction serious enough to be noticed. The percentage of operative frequency in Europe is variously noted by different workers. Knapp puts it at 61 per cent.; Heinsius, 56.84 per cent.; Ludwig and Savor, 45.6 per cent.; Bosmann, 24.5 per cent.; Franke, 20.5 per cent. In America the largest percentage is that of Flint, of New York, viz., 46. The well-known statistics of Reynolds, of Boston, are not at all reliable with regard to the frequency of all degrees of pelvic deformity, for, of the 2127 cases studied by him, measurements were made practically only in those in whom operative delivery was carried out.

Williams and Dobbin have shown that such a method of inquiry can result only in the non-recognition of a considerable number of deformities. This was demonstrated by their careful study of negro women. They found that pelvic contractions were much more frequent among these than among white women. Yet, on account of the small and easily moulded fœtal head, the degree of contraction is rarely sufficient to obstruct labor to a serious degree. Therefore, if only those cases were considered in which operative interference is necessary, a considerable number of deviations from the normal would be overlooked.

The most frequent contractions met with in practice are the following:

1. The justo-minor or universally contracted pelvis.
2. The flat non-rickety and rickety.

3. The funnel-shaped pelvis.
4. The pelvis altered by various spinal deformities.

Of these, perhaps the most common are the universally contracted and the flat.

Diagnosis of Anomalies of the Hard Pelvis in General. Three lines of investigation open to the obstetrician for determining the condition of a woman's pelvis:

1. A careful study of the history of her previous health and labors, and a thorough examination of her physical condition;
2. The study of the mechanism of labor itself;
3. Evidence may be gained from the condition of the child's head after delivery.

The latter two subjects will be considered with the individual pelves. In this section attention will be directed alone to the first heading.

In examining a woman her previous history should be inquired into. If she had suffered from rickets in childhood there would be a history of late dentition, irritability, bad digestion, restlessness and perspiration at night, late closure of the anterior fontanelle. She may have had bending of the long bones or spine, square head, pigeon-breast, rosary ribs, enlarged ends of long bones, and she may be of short stature.

Various deformities of the pelvis may be associated with rickets—*e. g.*, the *rachitic generally contracted*, the *rachitic infantile*, the *rachitic flat*, the *scolio-rachitic*, the *kypho-scolio-rachitic*, and the *rachitic rostrate* (*pseudo-malacosteon rachitic*).

The patient may have suffered from *osteomalacia*, in which case she would probably give a history of poverty, overwork, and exposure to cold and wet under unfavorable conditions of life, the disease having begun in a former pregnancy or lactation-period, with dull or aching pains in the limbs, back, and pelvis, worse on movement.

Tuberculosis may have affected her in one or other lower extremity, in the hip, or sacro-iliac joint, leading to a simple oblique contraction of the pelvis; or it may have occurred in the spine, giving rise to kyphosis, which secondarily may affect the pelvis.

The patient may have suffered from accident to a limb, resulting in shortening, dislocation, weakening, or amputation, secondarily leading to a single oblique contraction of the pelvis; or injury may have dislocated the lumbar vertebræ from the sacrum, causing the condition of *spondylolisthesis*.

Possibly the patient may give a history of a weakly early life, associated, however, with no special disease. Such a condition may be associated with a flattening of the pelvis or with some maldevelopment. Or she may have been born with a congenital dislocation of one or both hips, or with spondylolisthesis.

But the most satisfactory information is derived from the physical examination of the pelvis—pelvimetry. A series of measurements are to be made in the following systematic manner.

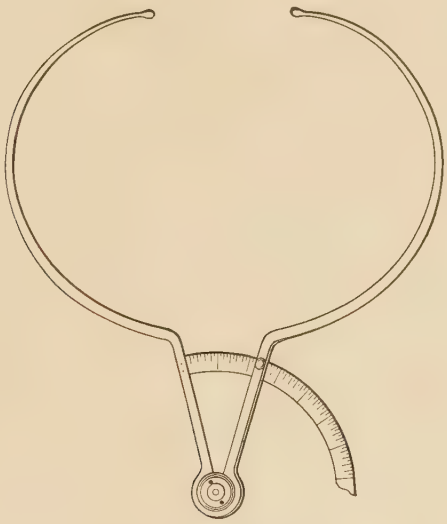
(*a.*) External Measurements.

1. **Antero-posterior.** An important antero-posterior measurement is that known as the "*External Conjugate of Baudelocque.*" To determine this, the patient is placed on her side, her hips being carefully exposed

and the clothes tucked out of the way. The physician stands behind the patient, looking toward her head. He then takes a pair of calipers, the so-called pelvimeter, and holds a rod in each hand, the tip of the index-finger being on each knob. The knob of one rod is placed in the depression just below the spine of the last lumbar vertebra, and the other on the skin of the mons veneris in front of the upper part of the symphysis. The rods are then fixed in position, a screw being turned by an assistant, and the measurement is read on the scale attached to the instrument.

To determine the length of the conjugata vera, it is necessary to subtract that which represents bones and soft tissues. This varies greatly in different cases and cannot be accurately determined. In 30 cases in which Litzmann measured the external conjugate during life and the true conjugate after death there was an average difference between the two of 9.5 cm. ($3\frac{3}{4}$ in.); in the whole series there was a range from 7 cm. ($2\frac{3}{4}$ in.) to 12.5 cm. ($4\frac{1}{16}$ in.). In some cases the conjugate of

FIG. 283.



Baudelocque's pelvimeter.

Baudelocque indicates contraction of the pelvis with certainty; in others, non-contraction with equal certainty. There are, however, many cases in which it cannot be relied on. Jewett states that with an external conjugate at or below 6 in. (15.2 cm.), or even below $6\frac{1}{4}$ in. (15.8 cm.), the pelvis is invariably contracted; at or above 8 in. (20.3 cm.) the pelvis is almost surely ample; between $6\frac{1}{4}$ and 8 in. the length of the vera is doubtful, and must be settled by other measurements.

There is another manner in which the vera may sometimes be made out in a thin non-pregnant woman, or in a pregnant woman whose uterus has not risen above the brim, viz., by placing the hand on the hypogastrium and pressing the abdominal wall with the tips of the straight-

ened fingers against the promontory; the thickness of the abdominal wall and pubes can be fairly correctly estimated and allowed for.

2. **Transverse.** The following measurements are usually made:

(*a*) Interspinous; between the outer edges of the anterior superior iliac spines. In normal cases this varies from $9\frac{1}{2}$ to $10\frac{1}{2}$ in. (24.1 to 26.7 cm.).

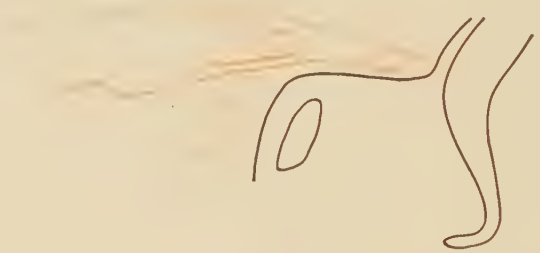
(*b*) Intercostal; between the outer edges of the widest parts of the iliac crests. In normal cases this varies from $10\frac{1}{2}$ to $11\frac{1}{2}$ in. (26.7 to 29.1 cm.).

In the normal pelvis the average difference between (*a*) and (*b*) is 1 in.

(*c*) Between the posterior superior iliac spines. This measures normally about $3\frac{7}{8}$ in. (9.8 cm.).

(*d*) Between the great trochanters. This measurement is not very reliable, owing to variations in the head, neck, and trochanter of the femur. If, however, it be less than $11\frac{1}{2}$ inches, transverse contraction of the pelvis may be suspected.

FIG. 284.



Measuring the conjugate in a non-pregnant rachitic woman by external application of the hands.

(*e*) Transverse of the outlet. The distance between the ischial tuberosities may be measured with a pelvimeter; or a finger may be placed on the inner edge of each, an assistant measuring between them with a piece of tape.

3. **Oblique.** The measurements made for the purpose of determining oblique contractions of the pelvis are given on page 459.

4. **Lozenge of Michaelis.** The size and shape of this area should be carefully determined, variations from the normal being present in many deformities. In the normal adult Caucasian woman, the angles and sides are nearly equal. The transverse diameter is a little longer than the vertical, measuring about $3\frac{7}{8}$ inches (9.8 cm.).

(*b.*) Internal Measurements.

For the purpose of determining the size of the pelvic canal the fingers alone are sufficient.

By a careful vaginal examination the wall of the canal may be pretty thoroughly examined. A good general idea of the capacity of the canal may be made out, projections can be felt, anchylosis of the coccyx can be determined, and the size of the outlet estimated. The height of the

symphysis can also be made out. Certain special measurements must, however, be made :

1. *The diagonal conjugate—i. e.*, from the promontory to the subpubic ligament. In determining this the patient should be placed in the lithotomy position, and the first two fingers, extended, should be passed up the vagina until the tip of the second finger touches the promontory. The radial side of the hand is then raised until it presses against the subpubic ligament, and a mark is made at this point on the hand, which is then withdrawn. With a pelvimeter the distance between this mark and the tip of the second finger is then taken. This is the length of the diagonal conjugate. In the normal pelvis it is $\frac{1}{2}$ to $\frac{2}{3}$ inch greater than the true conjugate of the brim. The difference between these diameters varies in different pelves, according to the height of the symphysis, the height of the promontory, and the angle between the vertical axis of the symphysis and the true conjugate.

Thus, in the rickety flat pelvis, where the height of the symphysis is greater than normal, and the angle between its axis and the vera is also greater, the difference between the diameters is greater than in the normal pelvis.

When the height of the symphysis is more than $1\frac{1}{2}$ in., slightly more than $\frac{2}{3}$ in. should be deducted from the diagonal conjugate.

In the great majority of cases a diagonal conjugate of less than $4\frac{1}{2}$ in. (11.5 cm.) indicates antero-posterior pelvic contraction.

2. *Löhlein's measurement*, from the subpubic ligament to the upper anterior angle of the great sacro-sciatic notch. This is said to be normally $\frac{3}{4}$ in. (2 cm.) less than the transverse diameter of the brim.

3. *Hirst's measurements*, from the promontory to the upper outer edge of the symphysis. This is taken with a special pelvimeter consisting of

FIG. 285.

Internal pelvimetry. Measuring the diagonal conjugate with the hands.

a long straight rod which is passed up the vagina to touch the promontory, and a short curved rod, which touches the front of the symphysis. When the instrument is in position its rods are tightened and then removed, the distance between the points of the rods being measured. The thickness of the upper parts of the symphysis is then measured

with a small pair of calipers and is subtracted from the first obtained length, in order to give the length of the true conjugate.

The transverse diameter of the brim cannot be measured through the vagina in the living woman. Sandstein has, however, shown that in nearly all types of pelves it equals half the length of the intercristal diameter, and that, for practical purposes, deviations from this relationship may be disregarded.

In measuring the diagonal conjugate with the fingers, there may be difficulty in reaching the promontory if the patient strains much, if the perineum is rigid, if the pelvis is very deep, or the promontory high or far back. The condition of double promontory, viz., that in which the junction of the first and second sacral vertebræ projects forward, like that between the last lumbar and first sacral, may exist and lead to an error in estimation; the point nearest the symphysis should always be chosen. In these conditions of difficulty the employment of general anæsthesia is of great value.

It is of great importance, also, to measure the conjugate and transverse diameters of the outlet. For this purpose special instruments are employed by some, but exact information can be obtained with the fingers and calipers.

The pubo-coccygeal diameter in the undisturbed condition of the coccyx averages 4 in. (10.2 cm.) in the normal woman, but when the coccyx is pushed back during labor the measurement may be increased to 5 in. (12.5 cm.).

The sacro-pubic diameter, measured from the subpubic ligament to the sacro-coccygeal joint, averages 4¾ in. (12 cm.).

Careful routine pelvimetry should be carried out by all who practice obstetrics. In this way alone it is possible to work with scientific accuracy and to avoid those risks to mother and child which are certain to attend him who establishes a diagnosis after the complications of a dystocic labor have begun.

X-Ray Pelvimetry. The *x*-rays may be used to determine various deformities of the pelvis, but are not yet very satisfactory in furnishing exact measurements of the various diameters.

Pelvigraphy. Neumann and Ehrenfest have devised a pelvigraph for the purpose of obtaining a graphic representation of the pelvic cavity during life. The principle involved in the instrument is that which is found in parallel rulers. As various points in the pelvis are touched they are reproduced on paper by another part of the instrument.

Cliseometry. Cliseometry is the method of measuring the angle of inclination of the planes of the inlet and the outlet of the pelvis. Various instruments have been devised by Naegele, Prochowniek, Neumann, and Ehrenfest. The procedure is of no value in practical obstetrics.

Classification.

Various classifications are employed in different countries. It is needless for the student to study the relative merits of these. It is best to select one as his basis of study, realizing that no system can satisfy all requirements of scientific completeness. The following plan is recommended:

I. Pelves normally proportioned but abnormal in size:
  1. Uniformly enlarged (*æquabiliter justo-major*).
  2. Uniformly contracted (*æquabiliter justo-minor*).

II. Pelves with anomalies of size, shape, inclination, or combinations of these:
  1. Those with minor developmental peculiarities: (*a*) Masculine (*b*) shallow, (*c*) deep, (*d*) funnel-shaped.
  2. Antero-posteriorly contracted:
     Flat, non-rachitic.
     Flat, rachitic.
  3. Obliquely contracted:
     By imperfect development of one sacral ala (Naegele pelvis).
     By imperfect or abolished use of one limb.
     By lateral spinal curvature.
  4. Transversely contracted:
     By imperfect development of both sacral alæ (Robert pelvis).
     By kyphosis of the spine.
  5. Compressed pelvis:
     Malacosteon.
     Pseudo-malacosteon rachitic.
  6. Spondylolisthetic.
  7. Pelvis distorted by injury, tumors, anchylosis of joints.
  8. Deformity due to spinal curvature:
     (*a*) Kyphotic.
     (*b*) Scoliotic.
     (*c*) Kyphoscoliotic.
     (*d*) Lordosis.

Individual Forms.

I. Pelves Normally Proportioned, but Abnormal in Size.

Uniformly Enlarged Pelvis (*æquabiliter justo-major*). This pelvis has all the characters of a normal pelvis, except that all the measurements are proportionately increased in size. They are found in large, though not necessarily in tall, women.

Owing to the lessened resistance to the passage of the fœtus, labor may be precipitate in such cases. Ahlfeld has, however, noted delayed labor several times, the head remaining in the pelvic cavity with the sagittal suture transverse.

Fig. 286.

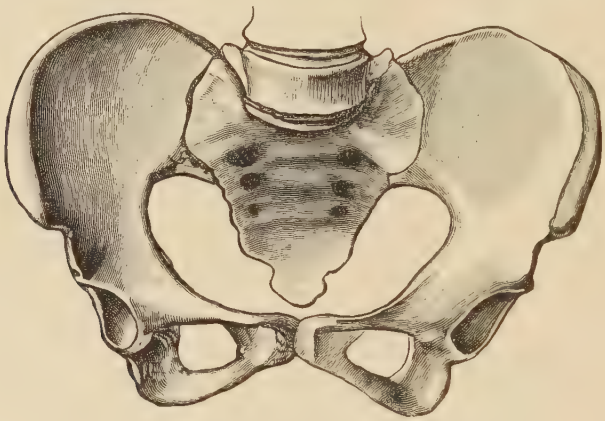
Diagram showing head unmoulded and moulded by labor in normal vertex case.
Black, unmoulded.
Red, moulded.

Influence on Pregnancy and Labor. In pregnancy the uterus tends to remain longer in the pelvis than in a normal condition, and, consequently, to disturb the bladder and rectal functions. It is generally believed that the labor is apt to be a hurried one. There is a greater tendency to post-partum hemorrhage, as Webster has shown, owing to the imperfect filling of the pelvis by the uterus.

Uniformly Contracted Pelvis (*æquabiliter justo-minor*). The most common form has the characters of a normal female pelvis save that all the measurements are proportionately diminished. It is found in women slightly undersized, but may also occur in persons of ordinary height or even in tall women.

Two other varieties are described by many authors, viz., the *infantile* form, in which, with the small size of the bones, many of the features

FIG. 287.



Generally contracted dwarf pelvis. (After WINCKEL.)

of the early pelvis are retained, and the *dwarf* form, in which the bones are slender and fragile, the cartilaginous junctions between the constituents of the *ossa innominata* being retained.

FIG. 288.

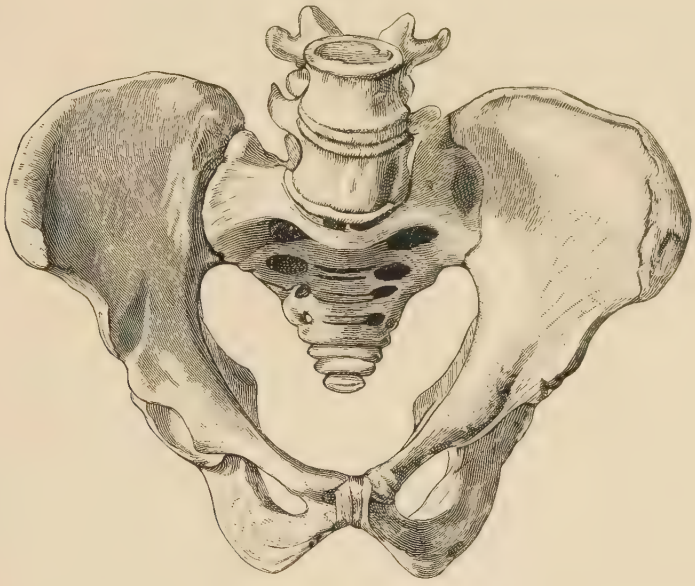
Diagram showing difference between normal and justo-minor pelvis on vertical mesial section. Black, normal. Red, justo-minor.

ETIOLOGY. The causation of this condition is not well known. In some cases it is due to imperfect development—*e. g.*, in dwarfs. In other cases it may be due to unfavorable hygienic surroundings and bad nutrition in early life.

Diagnosis. The diagnosis is based on careful pelvimetry. The lozenge of Michaelis is narrower than normal. The various diameters are proportionately reduced. The linea pectinea is more easily palpable. In advanced pregnancy the abdomen may be very prominent.

Influence on Labor. If the contraction is not too great to allow the fœtus to be born, the labor takes place by a definite mechanism which

Fig. 289.



Infantile pelvis. (After Ahlfield.)

resembles that in a normal pelvis, the flexion, however, being much more marked. In the normal pelvis flexion occurs so that the suboccipito-bregmatic diameter, drawn to the anterior angle of the bregma, comes into relation with the brim. In the justo-minor pelvis a shorter posterior suboccipito-bregmatic diameter comes into relation with the brim as a result of the increased flexion, depending upon the increased resistance with which the head meets. On examination, during labor, the tip of the occiput or even the external occipital protuberance (inion) may be felt in the centre of the canal.

Fig. 290.

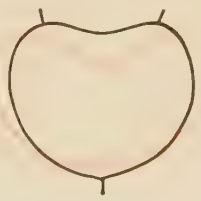


Diagram showing outline of brim of normal and of justo-minor pelvis.
Black, normal.
Red, justo-minor pelvis.

After flexion, internal rotation, extension, and external rotation occur as normally.

The labor may be much prolonged. Sometimes the pains may cease for a time, owing to the great resistance, or to the paralyzing effects due to the pressure on the soft parts between the fœtal head and the bony pelvis.

Head Moulding. The head is markedly compressed in the sub-

occipito-bregmatic diameter and elongated in the occipito-mental. In profile it has the shape of a sugar-loaf. This is all the more marked if a large caput succedaneum has formed over the tip of the occiput.

FIG. 291.

Diagram showing head unmoulded and moulded by labor in a justo-minor case.
Black, unmoulded.
Red, moulded.

TREATMENT. When the labor is delayed in a justo-minor pelvis forceps should be tried, provided the canal is large enough. This method may be employed when the brim conjugate is as low as 9.5 cm. ($3\frac{3}{4}$ in.).

The forceps is used because it assists the natural mechanism—*i. e.*, it allows the head to be well fixed. Walcher's position and the employment of *axis-traction forceps* make it possible to deliver a normal head through a brim whose conjugata vera measures 8.4 cm. ($3\frac{1}{4}$ in.).

Symphysiotomy has been recommended as an adjuvant to the above-mentioned method when the conjugata vera measures 7.6 to 8.4 cm. (3 to $3\frac{1}{4}$ in.). It has not been widely adopted.

Turning must not be employed, because the head becomes extended thereby, and the arms are apt to be displaced upward, greatly increasing the difficulty of a safe delivery of the head through the brim.

Abdominal Cæsarean section may be employed when the fœtus is alive and the forceps may not be safely used owing to unusual size of the fœtal head or small size of the canal. When the fœtus is dead, embryulcia may be carried out.

II. PELVES WITH ANOMALIES OF SIZE, SHAPE, INCLINATION, OR COMBINATIONS OF THESE.

1. *Those with Minor Developmental Peculiarities.*

(*a*) **Masculine.** Sometimes a woman's pelvis may present all the characteristics of a male pelvis.

Delay may be caused in labor either at the brim or outlet. Forceps may be required.

(*b*) **Shallow.** This term is applied to a pelvis in which the distance from the brim to the outlet is relatively less than in the normal pelvis.

Labor is not necessarily always easy in this form of pelvis. In the high forceps operation, however, there is less difficulty than in the case of a deep pelvis.

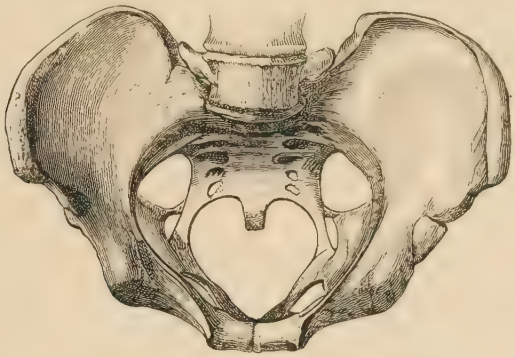
(*c*) **Deep.** In this pelvis there is an abnormal increase in the distance from the inlet to the outlet.

(*d*) **Funnel-shaped.** This term is applied to a pelvis in which there is a contraction of the pelvis at the outlet antero-posteriorly, transversely, or in both these directions. The canal, in fact, resembles that in the male pelvis, and by some authors "male" and "funnel-shaped" are used synonymously.

It must be remembered, however, that a pelvis may be funnel shaped without possessing any other male characteristics.

Diagnosis. The nature of the pelvis is made out by a careful comparison of the outlet and inlet measurements and by a careful examination of the pelvic canal.

Fig. 292.



Funnel-shaped pelvis. (After Winckel.)

Influence on Labor. The mechanism of labor may be interfered with—*i. e.*, flexion may be interrupted, or backward rotation of the occiput may occur. The labor is prolonged. The soft parts are unduly pressed against the bony wall—*e. g.*, the cervix against the promontory, or the bladder against the pubes, and laceration or necrosis may result. There is greater risk of rupture of the perineum.

Treatment. In the lesser degrees of contraction forceps should be used when there is delay. In more marked contractions, embryulcia, symphysiotomy, or Cæsarean section may be required.

2. *Antero-posteriorly Contracted, or Flat Pelves.*

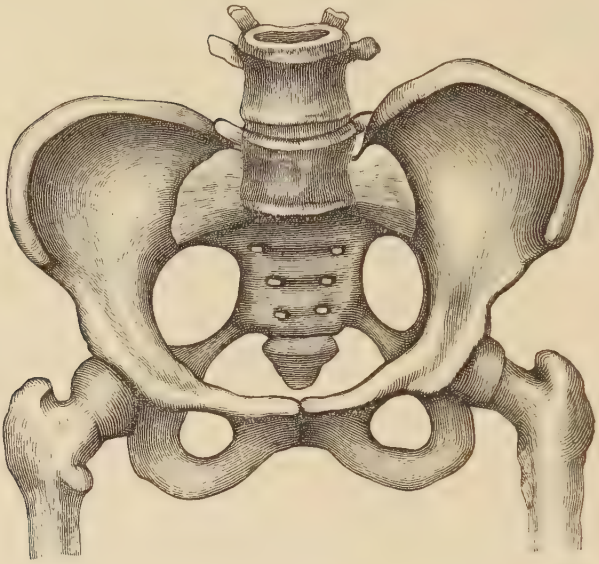
In these the characteristic feature is shortening of the conjugate of the brim.

(*a*) **Flat Non-rachitic, or Simple Flat.** This is a common variety in Europe, but rare in America. There is an approach of the whole sacrum to the pubes, the transverse diameter of the pelvis being, consequently, relatively increased. The conjugate in this form is rarely below three inches.

Etiology. The causes are not clearly known. Hard work in youth, a weakly condition of body, too early walking, lifting heavy weights, and excessive standing on the feet are believed to be important factors in causing the deformity. Sometimes the condition is congenital.

Diagnosis. There may be nothing diagnostic in the build of the individual. It may be found in large and small women. The relationship between the intercristal and interspinous diameters may be scarcely altered from the normal or not at all. There are no signs of rickets. The diagnosis is based upon the shortening of the external and diagonal conjugates.

FIG. 293.



Flat non-rachitic pelvis. (After KLEINWÄCHTER.)

(*b*) **Flat rachitic.** This is the most important form of flat pelvis. The following description may be regarded as that of a typical specimen:

FIG. 294.

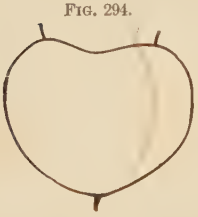


Diagram showing outline of brim of normal and Naegele pelvis.
Black, normal.
Red, Naegele.

In general, the pelvis is heavier than a normal one of corresponding size, owing to the increased condensation in the bones as a result of the disease. The bones are thicker, firmer, and somewhat smaller. The sacrum, however, is wider than normal.

The iliac crests do not possess the normal curve. They tend to become more or less everted at their anterior ends, so that the interspinous diameter approaches, equals, or is greater than the intercristal. The direction of the crests is partly due to the arrest of development, as the normal curve of the crests only appears after the age at which rickets occurs. The ilia are partly flattened also by the dragging of the sacro-iliac ligaments and the sartorii and glutei muscles. The iliac fossæ are not as distinctly hollowed, nor the iliac wings as expanded as in the normal pelvis; the fossæ look more directly forward. The wings are more stumpy than normal.

The brim is kidney-shaped, not heart-shaped, as in the normal pelvis.

The conjugata vera is less than the normal four inches, and the transverse is both relatively and absolutely increased.

The cavity of the pelvis is roomy and wider than in the normal state. The anterior surface of the sacrum is not concave from side to side, as in the normal condition, but, owing to the bulging forward of the bodies, it is either flat or convex.

The outlet has a widened transverse; the conjugate is normal or slightly increased.

The pubic arch is wide and the acetabula are directed more forward than in the normal state.

On vertical mesial section the symphysis is seen to be deeper than normal, its long axis not being parallel with that of the upper part of the sacrum, as in the normal condition, but tending to converge toward it above the brim. The main extent of the sacram is straight from above downward. Usually a sharp bend occurs about the fourth vertebra. The relation of the conjugata vera to the conjugata diagonalis is not the same as in the normal pelvis. In the latter the difference between them is about half an inch. In the rickety the difference is greater, three-quarters of an inch or more, owing to two factors, viz., the increased depth of the symphysis and the divergence of the lower margin of the symphysis from the normal position.

FIG. 295.

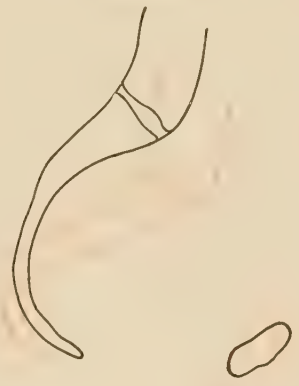


Diagram showing difference between normal and rachitic pelvis on vertical mesial section.

Black, normal. Red, rachitic.

ETIOLOGY. It is evident that these changes may be grouped around one main feature — the sinking of the promontory. Rickets causes in the early stages a softening of the bones, and if, in this condition, the body be kept to a considerable extent in the erect or sitting posture, its weight will tend to push the promontory downward and forward. The lower part of the sacrum, with the coccyx, tends to move upward and backward, but it cannot do so to any appreciable extent, on account of being held by the strong ligaments attached to it. Consequently, a sharp bend is produced about the fourth sacral vertebra. In addition to the weight of the body, the action of the muscles attached to the pelvis may help to bring about the deformity. The separation of the ischial tuberosities is due to the widening of the pelvis and to the action of the adductor and rotator muscles of the thigh. This will be increased by the weight of the body acting in the sitting posture.

Rickets usually develops in the early years of life. It may occur in utero, and the fœtus may be born with the pelvis somewhat altered; in the latter case probably the alterations are brought about by muscular action mainly. Great variations are produced by rickets, depending upon the date of its appearance, its severity, the habits of the child, etc. We have described the typical flat rickety pelvis. In some cases, where there is such a degree of disease as to permanently interfere with bone-development, a condition of pelvis known as the *rachitic generally contracted pelvis* may be induced; or a *rachitic infantile* pelvis may result, in which there is a narrow transverse diameter, relatively to the conjugate. Sometimes the pubes may be bent inward toward the promontory by muscular action, causing the brim to have a *figure-of-eight* shape. When the disease begins after the child has learned to walk and run, the weight

of the body is transmitted to the legs, and, owing to counter-pressure at the acetabula, they may be forced inward, thus giving rise to the *rachitic rostrate*, or *pseudo-malacosteon* pelvis.

When lateral curvature of the spine is present as a result of the rickets, the *scolio-rachitic* obliquely contracted pelvis is the result.

The vertical diameter of the lozenge of Michaelis is diminished owing to sinking of the promontory and lumbar vertebræ. In marked deformity, the upper angle may be almost in line with that joining the lateral angles.

Diagnosis. The diagnosis of a rachitic pelvis is formed from studying the woman's history, by her appearance, by examination and measurement of her pelvis. A woman who has suffered from the disease in childhood is usually undersized, with square head, flat nose, pigeon-breast, and with curved long bones whose ends are enlarged. When she lies on a flat surface, lumbar lordosis may be well marked.

Fig. 296.

Pregnancy in a woman with a flat rachitic pelvis. The condition of pendulous belly is shown.

By the pelvimeter the normal relationship between the interspinous and intercristal diameters is found to be altered, as already indicated. The external conjugate of Baudelocque is less than normal. The diagonal conjugate is less. The difference between the diagonal and true conjugates is greater than in the normal pelvis.

Sometimes a condition of double promontory exists, owing to the prominence of the junction of the first and second sacral vertebræ. In such a case the conjugates should be measured from the projection nearest the symphysis. Sometimes, on account of marked lordosis, the lumbar vertebræ may be nearer the symphysis than the real promontory; in this case the conjugates should be measured from the bony point nearest the symphysis.

Influence on Pregnancy and Labor. This has already been described (*vide* p. 433).

Mechanism of Labor in a Flat Rachitic Pelvis. Where the fœtus can be born, the passage of the head through the contracted brim takes place by a distinct and special mechanism.

In the normal pelvis the long diameter of the head lies at the beginning of labor, as Solayres first showed, in an oblique diameter of the brim. In the rachitic pelvis it lies in the transverse. In the normal pelvis the head is flexed; in the rachitic it becomes extended—*i. e.*, the sincipital end is lowered. In the normal pelvis the sagittal suture passes

through the central point of the inlet; in the rickety pelvis, as Naegele first showed, the suture is nearer the posterior wall, or, in other words, the occipito-frontal plane of the head is oblique to the plane of the brim.

As the second stage of labor proceeds extension of the head increases, the sinciput dipping, the occipital end of the head being well against the side of the brim, the short, bitemporal diameter being in relation to the conjugata vera.

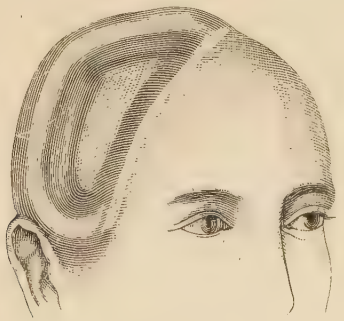
At the same time a movement takes place, known as the "rounding of the promontory." The head turns on its antero-posterior axis, so that the sagittal suture, instead of being near the promontory, approaches the symphysis; it then turns back again, so that the suture is nearer the back wall, now, however, being below the promontory. The head has, as it were, dodged round the promontory.

After the passage of the brim there is no obstruction in the true pelvis, and the rest of the mechanism may go on normally. Or, owing to the width of the transverse diameter of the outlet, the head may be forced onward without any special mechanism.

It is evident that should the head stick before it has passed the brim, different presentations may be made out clinically. Thus, a brow or face presentation may be found. One parietal bone may present, the sagittal suture being near the promontory, or the other parietal bone may present, the sagittal suture being near the symphysis.

Sometimes an altogether different mechanism may be attempted—*i. e.*, the head may attempt to get through one-half of the brim by a mechanism of extreme flexion. This mechanism may also be found in some cases of the *generally contracted rachitic* pelvis.

FIG. 297.



Depression of temporal region of skull as a result of delivery through a flat pelvis. (After E. MARTIN.)

Head Moulding. The characteristic feature is the presence of the "promontory mark"—*i. e.*, a depression in the parietal region which is in contact with the promontory during the passage of the brim. There is also generally a red mark on the skin, running from this depression toward the temple parallel with the coronal suture. Usually the parietal bone which was anterior in the pelvis overlaps the other.

BREECH DELIVERY IN A FLAT PELVIS. The delivery of the trunk

usually proceeds normally. The arms are more apt to be extended upward than in a normal pelvis. The after-coming head enters the brim in the transverse diameter. If the brim contraction is slight the head may pass through flexed; if great it becomes extended. Often it tends to stick above the brim.

Treatment. For a long period the classical method of treating a case in which the head presents has been that of version, providing the conditions are favorable. Recently, however, the use of the axis-traction forceps has been strongly advocated, mainly by Milne Murray, who claims that this method is as favorable to the child as version, and no more dangerous to the mother.

In a series of experiments Murray has shown that the diminution of the head in the occipito-frontal diameter is accompanied by a compensatory bulging, *not in the transverse*, but in the vertical diameter, and that, therefore, a serious objection to the use of the forceps is removed. By a simple and ingenious modification of the axis-traction forceps he has made it possible in these cases to make the line of traction coincide more accurately with the altered axis of the inlet than is possible with the ordinary axis-traction forceps. He and others have reported a number of cases in which his method has been successful in delivering a living child where marked contraction of the inlet existed. At the meeting of the British Medical Association in 1896 he mentioned one instance in which he had been successful where the brim conjugate measured 2.75 inches.

Comparing the relative merits of both methods in flat pelves, it may be stated against version (1) that it introduces the risks connected with breech deliveries, *e. g.*, asphyxiation of the fœtus from pressure on the cord, extension upward of head or upper extremities, injury to neck, etc.; (2) that it is impossible to bring down the child in the proper axis of the pelvis after version; (3) that turning becomes impossible or dangerous after the membranes have been for some time ruptured.

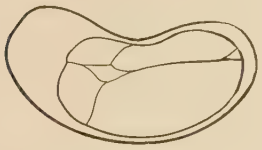
In favor of the forceps it may be said (1) that the fœtus is not exposed to the risks connected with head-last delivery; (2) that the manipulative risks are not so great as in version; (3) *that forceps can be applied long after dilation of the cervix and rupture of the bag of membranes;* (4) that the fœtus may be withdrawn more nearly in the pelvic axis; (5) that in the widened transverse diameter of the brim the blades of the forceps may usually be applied to the head without great difficulty; (6) that the grip of the head, just sufficient to prevent slipping, does not dangerously compress the head; (7) that the compression produced causes a compensatory vertical, and not an antero-posterior bulging.

Of great assistance in these cases is the employment of Walcher's position. (See Plate XVIII.). The patient lies across the bed so that her lower limbs hang over the edge, the feet not touching the floor. The weight of the legs draws the symphysis downward, thus increasing the conjugate of the inlet and correspondingly diminishing that of the outlet. As much as one-third of an inch increase in the brim conjugate may be gained.

A head may be drawn through the brim in this position when it is impossible to do so in the left lateral or lithotomy position. It is recom-

mended that when the head reaches the outlet the legs should be raised to make the conjugate of the outlet as long as possible; but as soon as

FIG. 298.



Moulding of head during passage through flat rachitic pelvis.

FIG. 299.

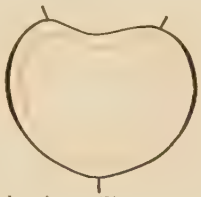


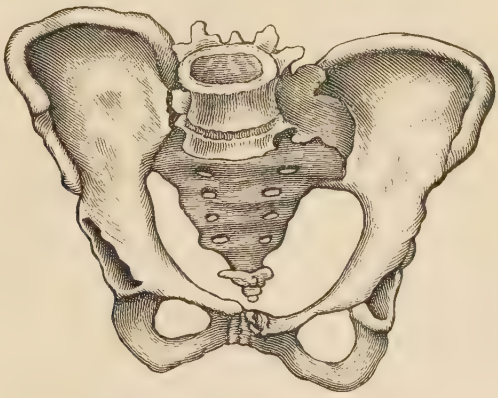
Diagram showing outline of brim of normal and of flat rachitic pelvis.

Black, normal. Red, flat.

the head has mainly passed the sacrum the limbs should be again placed in the Walcher position in order to relax the perineum. The raising of the legs is, however, unnecessary; the transverse is usually very wide in these cases, and the conjugate not diminished. There will, therefore, be little gain, even if the conjugate of the outlet be slightly increased.

Where delivery is impossible by these methods, embryulcia or Cæsarean section have been employed, depending upon the degree of contrac-

FIG. 300.



Singly obliquely contracted pelvis. (After HECKER.)

tion. By many, premature labor has been induced in these cases in the hope of getting a living child with safety to the mother.

After the recent revival of symphysiotomy, it was strongly advocated, for a time, as applicable to certain labors delayed by the deformity under consideration. Very few authorities have, however, adopted the procedure. It may be employed when the child is alive, when an instrumental delivery in the Walcher position is impossible, and when there is no doubt that the increased pelvic measurements resulting from the operation will allow the head to be extracted. Most authorities limit symphysiotomy in flat pelves to those cases in which the conjugata vera measures from 2.6 to 3.2 inches. It is evident, however, that the employment of the axis-traction forceps in the Walcher position must

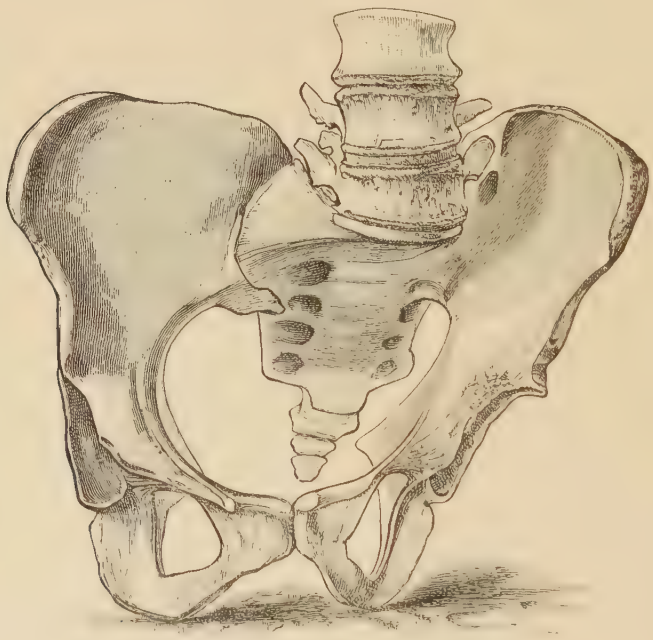
make unnecessary, in a considerable proportion of cases, the cutting operation. It is also clear that symphysiotomy at full time must greatly diminish the necessity for inducing premature labor in cases of pelvic deformity. For a living child delivery at term by the axis-traction forceps with the aid of symphysiotomy is preferable to a premature delivery with its risks and the uncertainty with regard to the rearing of a weakly child.

The delivery of the after-coming head in breech cases is best effected with axis-traction forceps.

3. *Obliquely Contracted Pelves.*

(*a*) **Resulting from Imperfect Development of One Sacral Ala** (*Naegele Pelvis*). This pelvis varies somewhat in appearance, according to whether part or whole of the sacral ala is wanting. In a well-marked condition

FIG. 301.



Singly obliquely contracted pelvis. (After WINCKEL.)

the characteristic feature is the single oblique contraction of the brim. The latter is of somewhat ovoid shape, the small end of the ovoid being at the sacro-iliac joint on the diseased side. The short oblique diameter is that of the healthy side—*i. e.*, if the left sacral ala is wanting, the shortened oblique diameter of the brim is the right.

The sacrum is narrowed, the sacral wing on one side being partly or wholly wanting. Often the sacro-iliac joint on that side is anchylosed. The front of the sacrum and the promontory are turned somewhat to the

diseased side. The os innominatum on this side is pushed upward, inward, and backward as a whole. The ischial tuberosity on this side is higher than that on the other, the ischial spine being closer to the sacrum and projecting more prominently into the pelvic cavity. The ilio-pectineal line is often less curved than on the healthy side. The subpubic angle is asymmetrical and looks toward the diseased side. The acetabulum on the diseased side looks almost directly outward.

Etiology. The deficiency in the sacral ala is due either to non-development or to some diseased state—*e. g.*, inflammation in early life. It may, therefore, be a congenital condition.

The distortion is aggravated when the child begins to walk, and it is easy to understand how the displacement of the os innominatum on the diseased side may be brought about. It is important to note that anchylosis of the sacro-iliac joint is not primary in this deformity; it is secondary, and is not always present.

Diagnosis. The diagnosis of the Naegele pelvis, especially where only part of the sacral ala is wanting, may be a difficult matter. The following measurements should be made with the pelvimeter: (1) From the anterior superior spine of one side to the posterior superior of the opposite; (2) from the posterior superior spine of one side to the tuber ischii of the other; (3) from the spine of the last lumbar vertebra to the anterior superior iliac spines of both sides; (4) from the posterior superior spine to the great trochanter on the opposite side; (5) from the lower margin of the symphysis to the posterior superior iliac spines.

These right and left measurements must be compared. Normally they should be equal or nearly equal. In the marked Naegele pelvis there is a considerable difference. Two other measurements may also be made, viz., from the middle line of the back to the posterior superior iliac spines; from the lower edge of the symphysis to the ischial spines, and from these spines to the nearest point of the sacrum.

Internal examination of the pelvic cavity must be made in order to detect the displacement of the lower portion of the os innominatum on the diseased side.

Influence on Labor. If the pelvis is roomy or the deformity slight, there may be no delay in the labor. When the contraction affects the passage of the head the mechanism by which it attempts to pass the brim is the same as in the case of a justo-minor pelvis—*i. e.*, by extreme flexion, the antero-posterior diameter of the head being in relation to the long oblique diameter of the pelvis. As the head descends it may fail to rotate to the front, and may turn to the back.

In a small pelvis with much contraction delivery is impossible.

Treatment. The axis-traction forceps should be tried where there is delay. Version is recommended by some, but owing to the nature of the contraction the former method is most indicated. Embryulcia has been used.

Premature labor may be induced as an alternative method. In extreme degrees of contraction Cæsarean section should be tried.

Symphysiotomy should not be employed, owing to the anchylosis of the sacro-iliac joint.

(*b*) **By Imperfect or Abolished Use of One Limb.** This may follow

unilateral disease of a hip or thigh in early life, if the person has been forced to use the sound limb to an excessive amount. The weight of the body is transmitted down the sound limb, and there results a flattening or curving inward of the os innominatum on that side in the region of the acetabulum. On the diseased side there is usually some degree of compensatory bulging outward of the corresponding portion of bone.

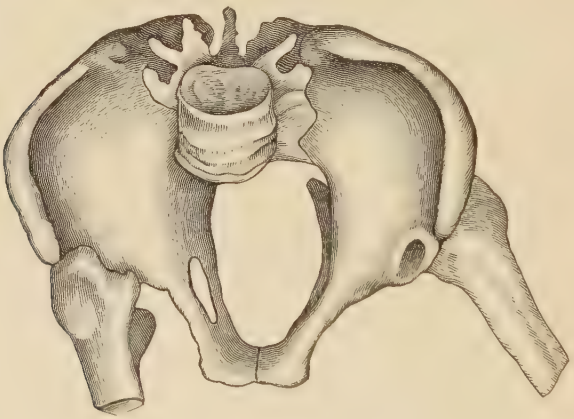
The same effect is brought about by amputation of one leg or by an old-standing dislocation.

(*c*) **By Lateral Curvature of the Spine** (see page 448).

4. *Transversely Contracted Pelves.*

(*a*) **By Imperfect Development of Both Sacral Alæ** (*Robert Pelvis*). This is a very rare deformity. The conditions are the same as in a Naegele

FIG. 302.



Transversely contracted pelvis. (After E. MARTIN.)

pelvis, only both sides are affected; hence by some authors the pelvis is called "*doubly obliquely contracted.*" In a typical, well-marked specimen there is marked approximation of both ossa innominata. The

FIG. 303.

Diagram showing outline of brim of normal and of Robert's transversely contracted pelvis. Black, normal. Red, transversely contracted.

men there is marked approximation of both ossa innominata. The sacrum is narrow, and is rectangular, not triangular. It is nearly

straight in its vertical direction. The ilia extend somewhat behind the sacrum, and there is a tendency to shortening of the conjugate of the brim.

In some cases both sides of the sacrum may not be equally maldeveloped. More than the sacral wings may be affected. There is usually secondary anchylosis of the sacro-iliac joints.

TREATMENT. Cæsarean section must be employed.

(*b*) **By Kyphosis of the Spine** (see page 449).

5. *Compressed Pelves.*

(*a*) **Malacosteon.** Various degrees of this condition are met with. In a typical well-marked specimen the following points are noticeable. The false pelvis is greatly altered in shape. The iliac fossæ, instead of having the normal saucer-like hollowing, are scoop-shaped, owing to the marked bending of the iliac wings, the anterior superior iliac spines turning inward.

The brim has a characteristic triradiate or stellate shape, owing to the approximation of the promontory and the acetabula. The

FIG. 304.

Diagram showing difference between normal and malacosteon pelvis on vertical mesial section.
Black, normal.
Red, malacosteon.

FIG. 305.

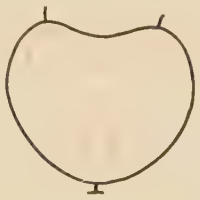


Diagram showing outline of brim of normal and of malacosteon pelvis.
Black, normal. Red, malacosteon.

pubic bones are close together, forming a kind of projection or beak. Hence this pelvis is often known as the rostrate or beak-shaped pelvis. The pubic arch is very narrow. The descending rami may be somewhat twisted. The ischial tuberosities are approximated and may be somewhat bent. The lower end of the sacrum with the coccyx is curved upward into the pelvic canal.

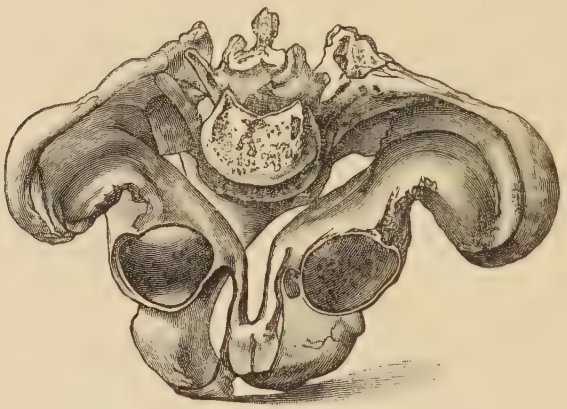
ETIOLOGY. The deformity is brought about when the pelvis is softened by the disease, osteomalacia (mollities ossium). This condition usually develops in the puerperium, but may occur in pregnancy. There is a removal of the lime salts from the bones. In the softened condition of the pelvis it is easy to understand how the weight of the body, the resistance of the lower limbs at the acetabulum, and the sitting posture may result in a crushing in of the pelvis, as has just been described.

DIAGNOSIS. The diagnosis is based on the history of the case and on external and internal examination of the pelvis. The gait is generally

peculiar: the body rotates greatly as one foot is advanced in front of the other.

Influence on Labor. In the softened condition of the bones labor may proceed naturally, though there are great dangers to the mother.

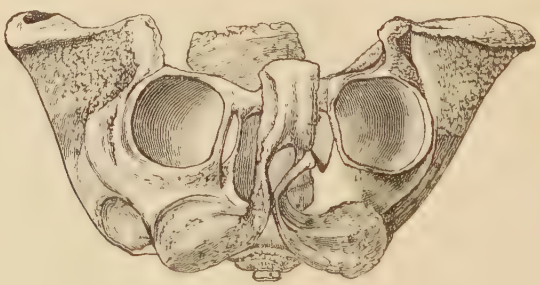
Fig. 306.



Malacosteon pelvis, seen from above. (After Winckel.)

In eighty-five cases collected by Litzmann there was a mortality of forty-seven. In the hardened condition, natural delivery is, in the great majority of cases, impossible

Fig. 307.



Malacosteon pelvis seen from front. (After Winckel.)

Treatment. In the softened condition of the bones forceps and version have been employed to aid delivery. Now, however, in these cases it is extremely likely that Cæsarean section with removal of the ovaries, or Porro's operation, will be employed, because of the curative influence which extirpation of the ovaries exerts on the disease.

When the bones are hard and the deformity fixed, the procedure depends upon the degree of contraction.

Embryulcia may sometimes be employed, but in the great majority of cases Cæsarean section must be carried out.

(*b*) **Pseudo-malacosteon Rachitic.** This form has already been alluded to in connection with rickets.

The pubis projects as a beak, the acetabula being somewhat pressed

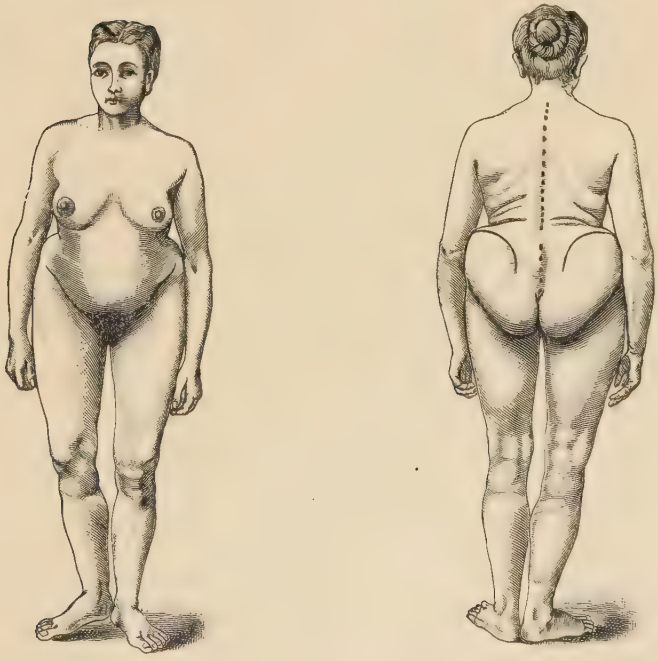
inward. The iliac wings are not scoop-shaped, as in the true malacosteon, but are widely separated anteriorly, as in the typical rachitic condition.

ETIOLOGY. This condition is due to rickets (see page 433).

FIG. 308.

Pseduo-malacosteon rachitic pelvis. (After SCHROEDER.)

FIG. 309.



Front and back view of woman with moderate degree of spondylolisthesis. (After WINCKEL.)

6. *Spondylolisthetic Pelvis.*

The characteristic feature in this deformity is the projection of the lower lumbar vertebræ into the true pelvis, owing to their downward

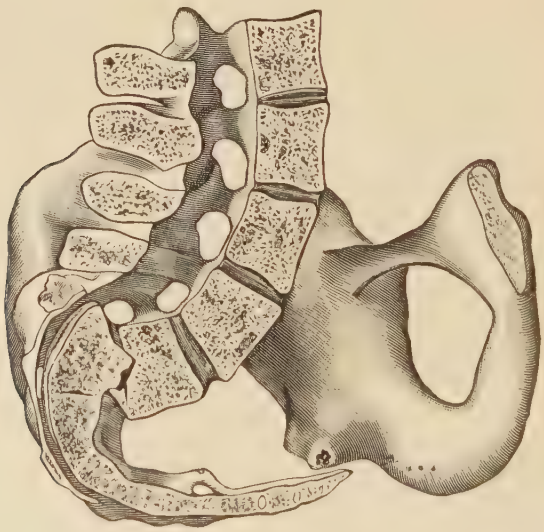
displacement. The sacrum is pushed somewhat backward and downward, and the symphysis rises. The inclination of the brim is thereby greatly lessened. The conjugate of the pelvis is diminished, varying according to the amount of descent of the vertebræ. The iliac crests are separated somewhat posteriorly.

The pelvic outlet is narrowed both transversely and antero-posteriorly.

Etiology. The causation of this condition is not very clear. Injury, disease, and developmental errors are believed to be predisposing causes. Lane believes that extra pressure from above may bring about the condition, even when the bone is healthy.

Diagnosis. The history must be carefully studied. There may have been an accident—*e. g.*, a fall, or the woman may have been accustomed to carry heavy weights. The height is diminished and the abdomen shortened vertically, and it is somewhat pendulous. Seen from behind the posterior parts of the iliac crests are very prominent. The articular processes of the first sacral and last lumbar vertebræ are very distinct below the skin. The ribs are close to the ilia and the flanks are well marked. The shoulders are carried well back. When the woman walks the footsteps fall in a straight line, the toes not turning outward. Sometimes she complains of a grating sensation (crepitus) in the lumbar region.

Fig. 310.



Spondylolisthetic pelvis. (After E. Martin.)

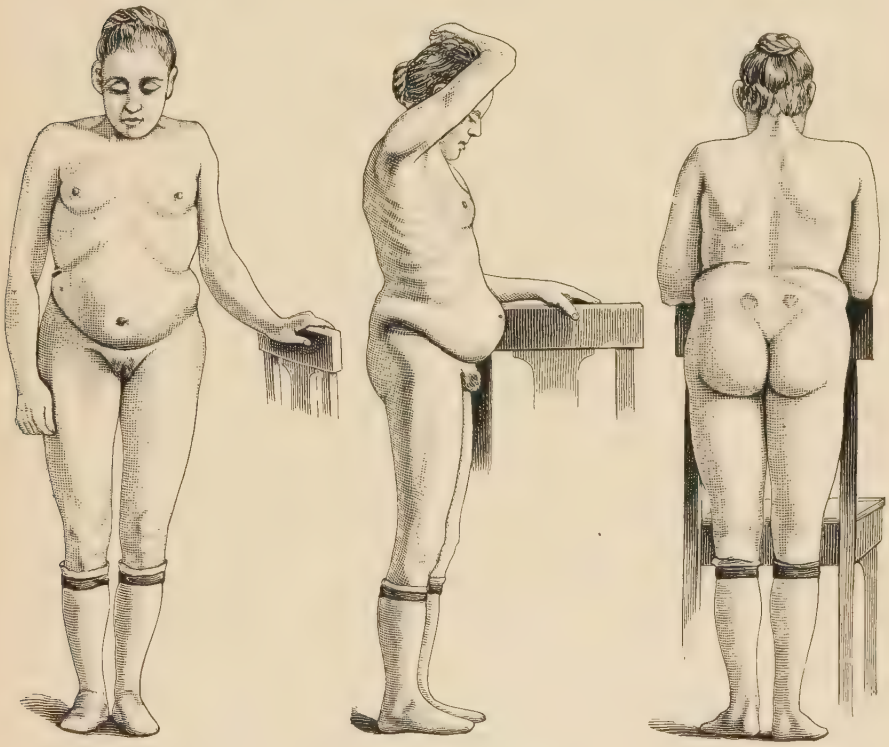
Owing to the rotation on the pelvis, the vulvar region is carried forward. On external examination the symphysis is found to be higher than normal, the brim with a lessened inclination, the distance between the posterior superior iliac spines increased, and the external conjugate of Baudelocque diminished.

On internal examination the projection of the lumbar vertebræ is distinguished, as well as the contracted outlet. The iliac vessels are lower than normal, and it may be possible to feel the lower end of the aorta.

The diagonal conjugate must be measured from that point on the lumbar projection nearest the symphysis. Owing to the variations in the inclination of the pelvis and in the degree of deformity, there is no constant relationship between the diagonal and true conjugates. The former is generally a little greater, but it may be equal to or less than the latter in a few cases.

Influence on Labor. The deformity being of the nature of a flattening of the pelvis, the mechanism of labor, providing the head can be born, resembles that found in a flat rachitic pelvis. In some cases

Fig. 311. Fig. 312. Fig. 313.



Different views of a woman possessing a spondylolisthetic pelvis. (After Ahlfeld.)

natural delivery is impossible. Bad ruptures of the pelvic floor are common.

Treatment. Labor is conducted on practically the same lines as laid down in connection with rachitic pelves.

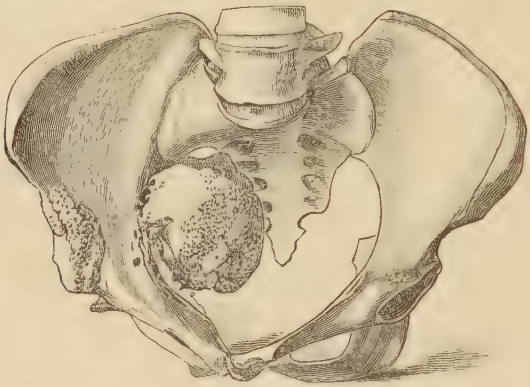
7. *Pelves Distorted by Injuries, Disease, Tumors, etc.*

(*a*) **Double Dislocation Backward of the Femora.** This rare condition is generally congenital. It results in marked rotation forward of the sacrum, increased width of the pelvic cavity and outlet, the tuberosities of the ischium being dragged outward, upward, and backward.

(*b*) **Tumors.** The commonest are exostoses at the joints—*e. g.*, sacro-

iliac, symphysis, promontory, sacral. They may be sharp or rounded, and vary greatly in size. They may also occur on the ileo-pectineal line.

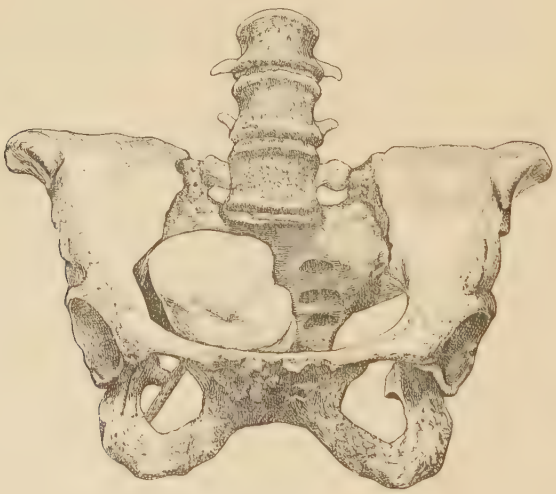
FIG. 314.



Bony outgrowth of right half of pelvis. (After WINCKEL.)

These exostoses may interfere with normal labor, and they may injure both maternal and fœtal parts.

FIG. 315.



Malignant growth of posterior wall of pelvis which necessitated Cæsarean section in a case of Dr. Cameron.

Other tumors of the bone may distort the pelvis—*e. g.*, fibroma, sarcoma, carcinoma, enchondroma, cysts. Cystic conditions occur in sarcoma, enchondroma, and hydatids. Carcinoma is always a secondary growth; it may lead to great softening of the bone.

TREATMENT. Where the growth is too large to admit of delivery by the natural passages, Cæsarean section or embryulcia must be performed. Symphysiotomy is sometimes performed in these cases, but not where the sacro-iliac joints are involved in the tumor. Embryulcia is to be especially considered if the child be dead.

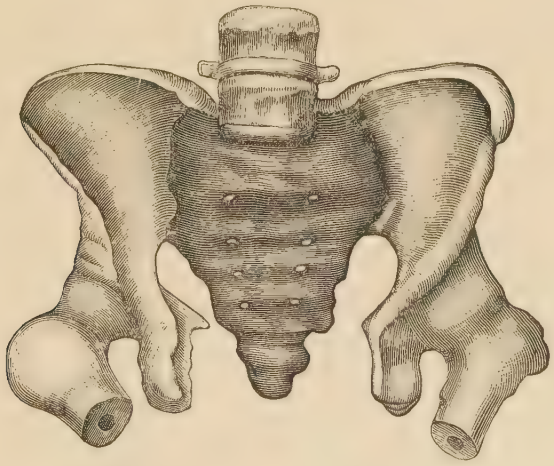
(*c*) **Fractures of the Pelvis.** Deformity due to this injury is very rare. It may result from bad union of the broken bone, from marked callus-formation, or from ossification of the joints near the fracture.

(*d*) **Anchylosis of Joints.** This condition may occur in any pelvic joint. When at the symphysis, it is not a serious matter as regards labor; but it makes symphysiotomy a more difficult operation.

In the sacro-iliac joints it is a more serious matter. When it occurs in early life it may interfere somewhat with the development of the adjacent parts of the sacrum and ilium, and so the pelvis may be somewhat obliquely contracted. This is a rare condition, however.

The sacro-coccygeal and coccygeal joints may sometimes become anchylosed. More commonly the sacro-coccygeal alone is affected. In the former case there may be marked obstruction to labor, and fracture of the coccyx may result.

FIG. 316.



Split pelvis. (After KLEINWÄCHTER.)

(*e*) **Split Pelvis.** This is a rare condition, being due to a maldevelopment in the anterior wall of the pelvis. It is not a cause of delay in labor, but is rather apt to be associated with rapid delivery.

8. *Pelvic Deformities Due to Spinal Curvature.*

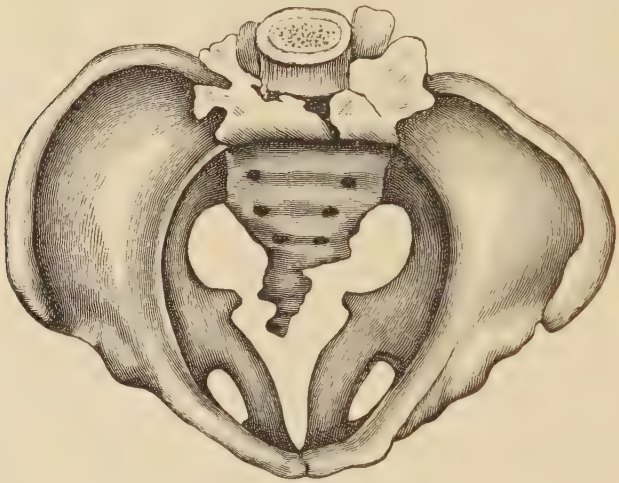
(*a*) **Kyphotic.** This deformity varies greatly, according to the extent of the kyphosis. The nearer the sacrum the spinal hump, and the more prominent it is, the more marked the changes in the pelvis. Generally the kyphosis is in the region of the junction of the dorsal and lumbar vertebræ.

Owing to the spinal curvature the centre of gravity of the body above it is thrown forward. Some degree of lordosis is brought about by way of compensation, but this is not sufficient, and a rotation of the sacrum occurs, so that the upper end is thrown backward and downward. There is also a rotation of the ossa innominata upon their antero-posterior axes.

When the curvature is prominent and very low, that part of the spine projecting forward above the hump may project over the brim so as to interfere seriously with the uterus and fœtus—this condition has been termed *pelvis obtecta* by Fehling.

The characteristic alteration in the pelvis is the change in the brim, from the normal heart-shape to an oval, in which the long diameter is antero-posterior. This results from the backward movement of the promontory, whose prominence may entirely disappear. The sacrum becomes longer, narrower, and straighter. The posterior superior iliac spines are drawn nearer to each other and the anterior are separated.

FIG. 317.



Kyphotic pelvis. (After KLEINWÄCHTER.)

The pelvic canal may become markedly funnel-shaped, owing to the movement forward of the lower part of the sacrum, and to the approximation of the ischial tuberosities; but many variations are found in the degree of contraction. The lower the kyphosis the more will the portion of the spine which projects forward tend to interfere with the brim.

FIG. 318.

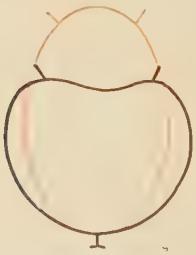


Diagram showing outline of brim of normal and of kyphotic pelvis. Black, normal. Red, kyphotic.

FIG. 319.

Diagram showing outline of brim of normal and of scoliotic pelvis. Black, normal. Red, scoliotic.

Sometimes the upper part of the sacrum may be affected by the necrosis which has caused the kyphosis, and some extra deformity may thus be brought about in the sacrum.

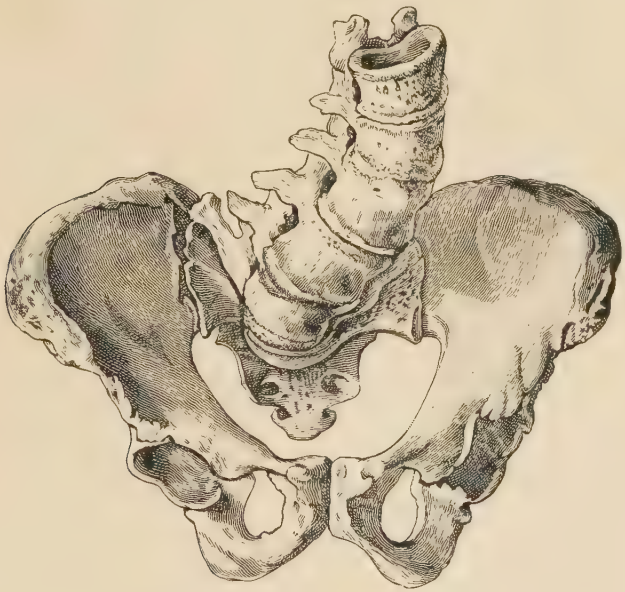
DIAGNOSIS. The diagnosis is easy from examination and from the woman's history. The condition of the cavity and outlet especially

must be noted with extreme care. During pregnancy the uterus is more prominent than normal if the deformity be at all marked, and thus malpresentation or malposition may be brought about.

Influence on Labor. The obstruction to labor occurs in the lower part of the pelvic canal. If the degree of contraction is slight, labor may be easy and quick. So frequently may this be the case that a saying is common in some parts of Europe to the effect that "Hunchbacks have easy labors." In a marked degree there is delay, and abnormal rotation of the head is apt to occur. In a more marked degree of contraction birth is impossible. There is special danger of post-partum hemorrhage, owing to the imperfect filling of the upper part of the pelvis by the uterus.

Treatment. This varies according to the degree of contraction. In slight cases forceps may be used successfully. In worse cases embryulcia or premature labor may be necessary. In extreme contraction Cæsarean section is demanded.

Fig. 320.



Kyphoscoliotic-rachitic pelvis. (After Ahlfeld.)

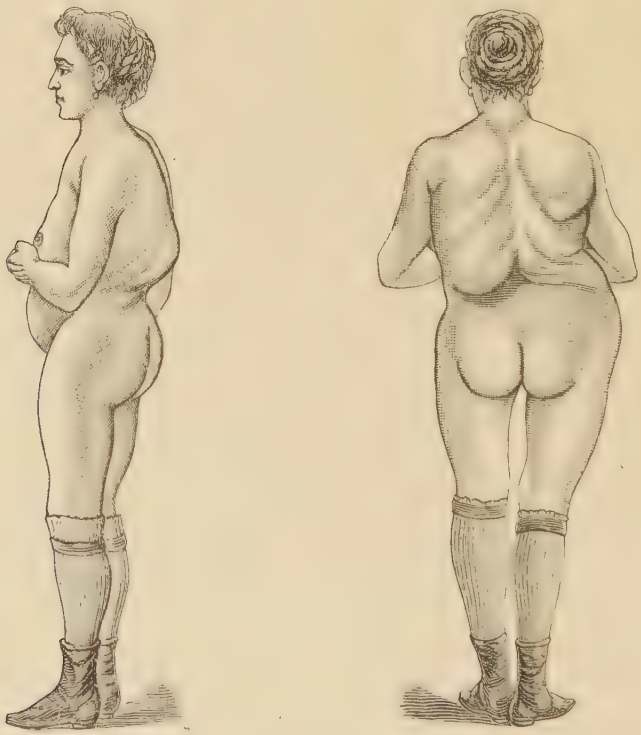
(*b*) **Scoliotic.** When lateral curvature affects the spine its effect on the pelvis depends on its situation and extent. The lower the bend in the spine and the earlier its occurrence, the more marked will be the pelvic deformity. As scoliosis is generally associated with rachitis, the scoliotic pelvis will show certain changes due to that disease. The special alterations induced by the spinal condition are as follows: That half of the pelvis toward which the convexity of the curvature is directed receives an extra amount of the weight of the body. The innominate bone, therefore, on that side tends to be pushed upward, backward, and inward by the resistance of the femur. The acetabulum is curved in somewhat toward the sacrum, so that the shortest diameter of the brim is that between the promontory and the ilio-pectineal eminence, the so-called

sacro-cotyloid diameter. There is also some rotation of the lumbar vertebræ toward the side of the convexity. If there is much rachitis the promontory may be well forward, the sacral wing on the side of the spinal convexity being prominent. Thus the marked deformity is seen to be on the side of the convexity.

Influence on Labor. When only slight degrees of deformity exist the child is born by the mechanism observed in the case of the rachitic pelvis. If the deformity be more marked, one-half of the pelvis, viz., that on the side of the convexity, is of no use, and the head may attempt to pass the larger part of the brim by a mechanism like that seen in a universally contracted pelvis. Embryulcia has been employed in some of these cases. Symphysiotomy has also been tried. But, practically, in all cases where deformity is at all marked, Cæsarean section is indicated.

(*c*) **Kyphoscoliotic.** Rachitis may cause both kyphosis and scoliosis in the same woman. If both are situated low in the spine the pelvis may

Fig. 321. Fig. 322.



Views of a woman with kyphoscolio-rachitic pelvis. (After Martin and Fassbender.)

show certain characteristics due to both these conditions. Generally the kyphosis is situated high in the dorsal region, and is compensated for by a lumbar lordosis, so that the pelvis is not affected by the kyphotic curvature.

(*d*) **Lordosis.** Primary lordosis is so rare a condition that no notice

need be taken of it in this connection. It is usually secondary to spinal disease or to pelvic deformity.

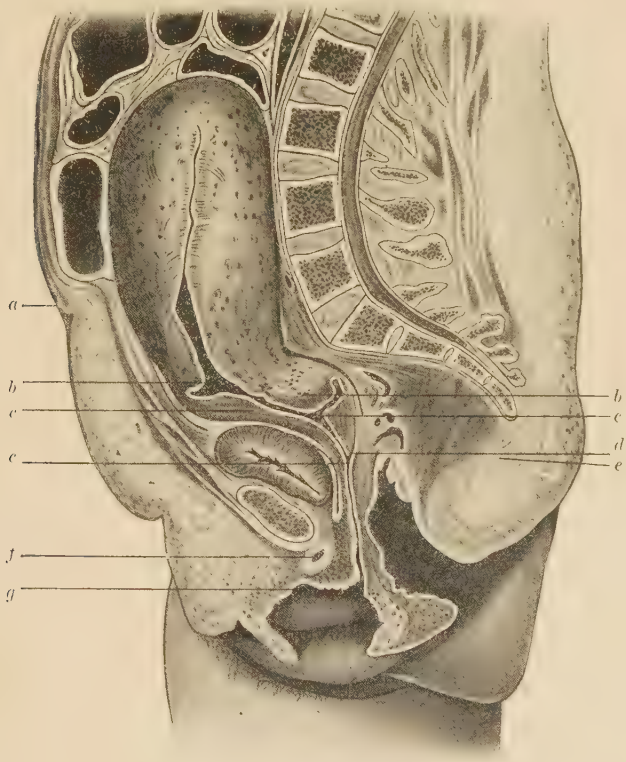
If low down in the spine, it may interfere with the uterus in pregnancy and with the entrance of the child in the brim during labor.

Pelvic Deformity in Relation to the Post-partum State.

That a deformed pelvis may exert a marked influence on the character of the post-partum state is not generally recognized; yet careful observations show that the relationship is one which cannot be ignored.

Some years ago it was the writer's good fortune to be able to investigate the cadavera of a number of women who died at various periods in

FIG. 323.



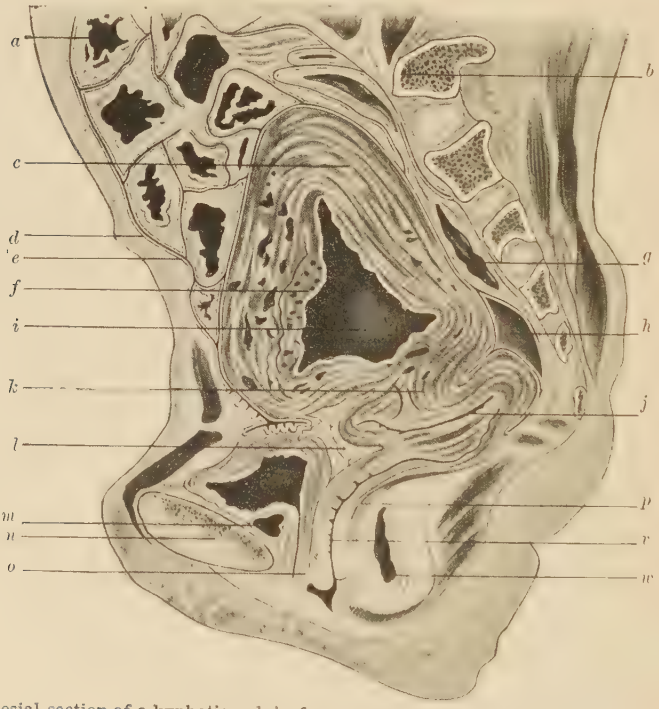
Vertical mesial section of a contracted pelvis, from a woman who died a half-hour after delivery, of post-partum hemorrhage.

a. Umbilicus; *b*, retraction ring; *c*, cervix; *d*, posterior fornix; *e*, tip of coccyx; *f*, urethra, *g*, urethral orifice. (STRATZ.)

the puerperium, of conditions not affecting the normal relationships of the pelvic contents. By means of frozen sections it was possible to describe accurately, for the first time, the topography of the puerperal pelvis. Sections showed that in the normal state, immediately after the third stage, the retracted and contracted uterine body fills the greater

part of the pelvic cavity and compresses the extra-uterine tissues, this compression being especially marked between the uterus and the bony wall, and to a much less extent inferiorly, owing to the softening and relaxation of the fascial and muscular tissues of the floor of the pelvis. In consequence of this arrangement the circulation of the blood in the extra-uterine pelvic structures is considerably interfered with, those parts inferior to the body of the uterus—viz., the cervix, vaginal walls, perineum, and subpubic tissues—being congested, while those tissues compressed between the pelvic wall and uterine body are anæmic, many of the vessels being closed or nearly closed. In the uterine body itself

FIG. 324.



Vertical mesial section of a kyphotic pelvis, from a woman who died one and a half hours after delivery, of post-partum hemorrhage.

a, intestines; *b*, last lumbar vertebra; *c*, uterus; *d*, peritoneum; *e*, placental site; *f*, uterine cavity; *g*, rectum; *h*, pouch of Douglas; *i*, cervix; *j*, cervical canal; *k*, cellular tissue; *l*, bladder; *m*, vein; *n*, symphysis pubis; *o*, urethra; *p*, cellular tissue; *v*, vagina; *w*, anus. (BARBOUR.)

there is marked anæmia, owing to the compression of vessels by the retracted and contracted musculature. This condition of things lasts for the first four days of the puerperium. Both as a result of the state of the uterus and of the compression of extra-uterine tissues by the organ against the pelvic wall, bleeding from its inner surface is greatly interfered with, while a marked influence is exerted by the greatly altered circulation in the direction of initiating or assisting the retrogressive changes which cause uterine involution. Further, the condi-

tion of the cervix and vagina aids to an understanding why after labor there is so often bleeding as a result of tears; and why, if the laceration has extended into the paracervical and paravaginal tissues so rich in venous sinuses, there may be very severe hemorrhages.

During several years the writer has made careful observations regarding post-partum hemorrhage in cases of normal and abnormal pelves, and he has found it to be most profuse and most difficult to check in women with abnormally large pelves and in those with abnormally contracted pelves. Of the former, may be mentioned the justo-major or universally enlarged, and the kyphotic, in which the upper part of the pelvic cavity is much increased; of the latter I may mention the rickety pelvis. The explanation of these facts is very evident from the study of cadavera. Barbour, of Edinburgh, has published an interesting case of a kyphotic woman who died one and a half hour after delivery, of post-partum hemorrhage, and his sections of the frozen body show that the uterus in no way acts as a plug to the large size of the upper part of the pelvic cavity, the extra-uterine tissues being markedly congested, the large vessels dilated—conditions all favorable to excessive bleeding. On the other hand, in the case of a well-marked contracted brim, as is shown by Stratz's section of a rickety woman who died of post-partum hemorrhage one-half hour after delivery, the uterus cannot sink down into the pelvis, the cervix, vagina, and extra-uterine pelvic tissues being thereby allowed to become enormously congested.

The Prevention of Dystocia.

During the last century various attempts were made to influence the growth of the fœtus during its intra-uterine life, so that labor might be rendered less difficult in cases in which there had been dystocia. These consisted in purging, bleeding, or underfeeding the mother.

In 1841 Rowbotham, a London chemist, published a pamphlet describing the success which had followed the treatment of his wife by restriction of her diet. For many years his system was carried out among the laity, but was little noticed by the profession.

In 1889 Prochownick gave an account of some cases in which he claimed that pregnancy had been made to terminate in satisfactory full-time labors by dietetic restrictions to which the mothers were subjected during the last two months of pregnancy. He believed that this method of treatment would result in the development of a small fœtus, which might in a large percentage of women with contracted pelves be born at full time, thus rendering serious operations and induced premature labor less frequently necessary. He emphasizes the increased capacity of the skull for moulding.

His diet was as follows:

Morning: Small cup of coffee and 6 drachms of Zwieback.

Noon: Any kind of meat, eggs, or fish, with very little sauce. Some green vegetable, with fat added. Salad, cheese.

Evening: As above, with addition of 1½ ounce of bread. Butter as desired.

Fluids, per diem, limited to 12 or 15 ounces of red or Moselle wine.

To be entirely avoided: Water, soups, potatoes, cereals, sugar, beer.

Several workers have reported successful cases treated by Prochownick's method, but it has not been sufficiently tested to warrant its widespread adoption.

B. Soft Parts.

1. Uterus.

Developmental Anomalies.

When labor takes place in the case of a unicornate uterus there are apt to be malpresentations and positions, mainly owing to the inclination of the long axis of the cornu to the pelvic canal.

In the case of pregnancy in one horn of a bicornate uterus the same tendency exists. Here also labor may be obstructed by the recto-vesical ligament which runs between the cornua. Where both horns are pregnant obstruction is likely to occur from jamming together of the twins.

In the case of a pregnancy in one half of a septate uterus, the unimpregnated half may act as a mechanical obstruction or the septum may do this.

In all these cases the labor pains may often be weak, short, and inefficient. Rupture of the uterus may occur. Severe post-partum hemorrhage may result.

Treatment. It may be necessary to assist delivery by version or forceps. In such cases the greatest care should be used in order that the uterine wall be not ruptured. Version should be employed as little as possible. Embryulcia or Cæsarean section may be necessary sometimes. When a septum is an obstruction it may be cut through.

When pregnancy occurs in the rudimentary horn of a bicornate uterus, the case is very grave and must be treated as one of tubal gestation.

Atresia of the Cervix.

This is acquired after conception, usually from the use of escharotics, and is seldom complete. Generally a dimple exists at the site of the os externum. If the condition be not relieved rupture of the uterus will take place.

Treatment. With a sound a small opening may be made through the dimple. Sometimes it is necessary to make a crucial incision. Dilation usually follows naturally. If there is sharp bleeding, ligatures may be necessary.

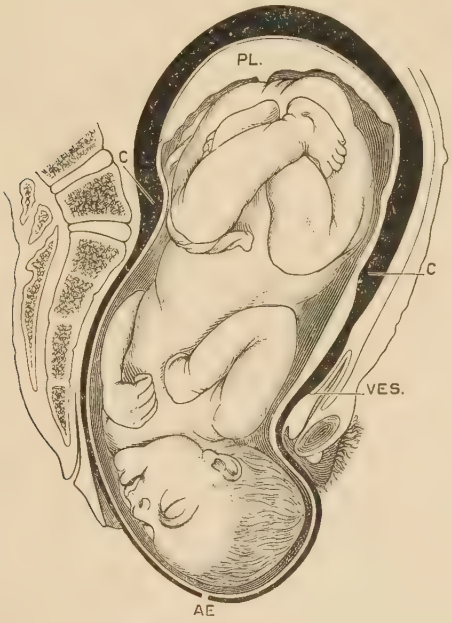
Rigidity of the Cervix.

This condition causes delay in the first stage of labor. It may be functional or organic. Functional rigidity is either *constitutional*—*e. g.*, as met in elderly primiparæ, or *spasmodic*. In the latter condition, the cervical sphincters do not relax between the pains, and the *os externum* tends to become smaller during the pains. This condition is usually associated with inefficient contractions of the body of the uterus.

Organic rigidity is due to various causes. Former lacerations may have led to the formation of much cicatricial tissue in the cervix, or this condition may succeed operative procedures.

Syphilitic changes or new growths sometimes cause rigidity.

FIG. 325.



Stenosis of the cervix uteri obstructing labor. (After JENTZER.)

TREATMENT. In the constitutional, spasmodic, and inflammatory varieties, hot douches, frequently given, are serviceable. Chloral, morphia suppositories, or large doses of opium in pills may be administered. Large doses of chloral are to be preferred, because this drug causes dilation painlessly without interfering with the pains; morphia tends to suspend the pains. If the patient be exhausted chloroform may be given, and a hypodermic of morphia to induce sleep for a few hours.

It may be necessary to assist dilation by separating the membranes from the lower uterine segment as much as possible and by pressing the lips of the cervix apart with the fingers. Rubber dilators, *e. g.*, Barnes's or Champetier de Ribes's, are valuable when the other methods fail.

Sometimes several incisions, one-half inch deep, must be made in the cervix. These should immediately precede artificial delivery.

IMPACTION OF THE CERVIX.

In the case of rigid cervix, hypertrophy of the cervix, or in pendulous belly, where the os externum is directed to the back, the anterior lip may be caught between the head and the pubes, and, becoming swollen and œdematous, may impede labor, or, after labor, may slough. In these

cases attempts should be made to push the cervix up between the pains. When this is impossible, it is best to draw the head through with forceps or to make incisions in the cervix.

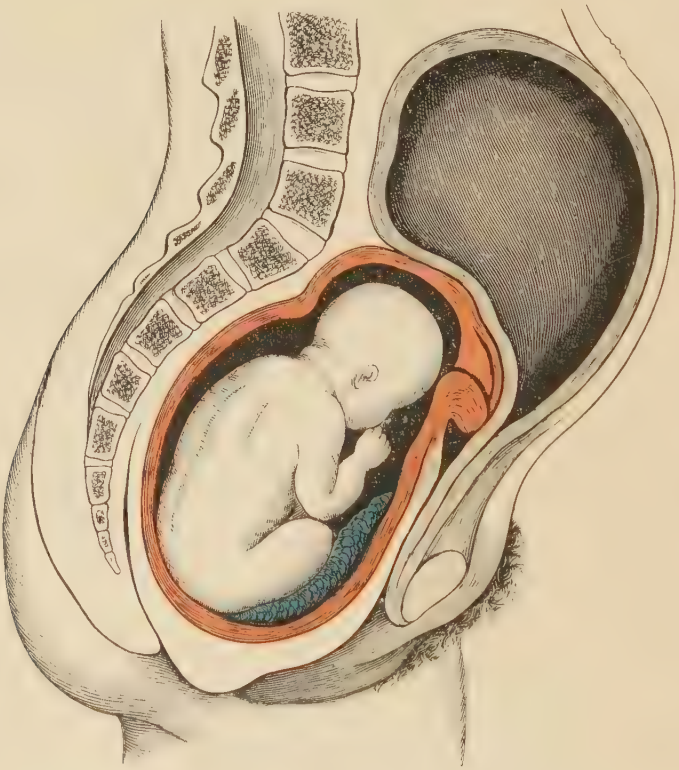
Malpositions of the Uterus.

Anteversion. When there is marked anteversion in pendulous belly, or as a result of separated recti, the uterine force may be so badly directed that dilation takes place very slowly.

Treatment. The patient is kept on her back, an abdominal binder being used to hold the uterus in position.

Hernia. A pregnant uterus may fall into an umbilical hernia or into a ventral hernia following a laparotomy. Sometimes an inguinal hernia may contain a pregnant uterus.

Fig. 326.



Retroflexion of the gravid uterus. (After Schatz.)

Treatment. The dorsal position and the binder are employed to keep the uterine axis properly directed. In the case of an inguinal hernia the child may be delivered by version, and the uterus afterward withdrawn from the hernia. But it is probably best to open the hernial sac, removing the fœtus from the womb and amputating the latter. This condition is usually found with a unicornate or bicornate uterus.

Latero-version. Marked tilting of the fundus to one or other side may sometimes occur. The patient should be placed on the side toward which the fundus is directed, and a pillow should be put under that side of the belly during labor.

Sacculation. Where a retroflexion of the gravid uterus has occurred in the early months, the pregnancy having advanced to term, there may be formed a kind of diverticulum behind the cervix, the latter being usually above the brim against the abdominal wall. The posterior vaginal wall is markedly bulged downward and forward, and the fœtal parts may be so easily felt as to suggest an ectopic gestation; or the projecting vagina may be mistaken for a bag of membranes.

Treatment. The cervix should be dilated artificially and version performed. It may be necessary sometimes to perform Cæsarean section.

Prolapsus Uteri. Complete prolapse of the pregnant uterus is unknown. Various degrees of partial prolapse have been met with.

Often when pains set in the prolapsed portion is drawn up. But if the cervix be rigid or much hypertrophied, this does not happen, and the prolapsed portion may become œdematous, and, consequently, more pronounced.

Treatment. See "Impaction of the Cervix."

Labor in Cases in which previous Operative Measures for Displacement of the Uterus have been carried out.

It is too soon to decide as to the frequency of complications in labor due to the various operations which have been carried out for displacements of the uterus. Only an approximate idea of their relative importance can be given.

Shortening of the round ligaments by any method has rarely been reported as causing trouble in labor.

Vaginal fixation and ventro-fixation are the most serious causes of trouble, the former more frequently than the latter. Malpresentations and malpositions of the fœtus, inertia uteri, rupture of the uterus, and post-partum hemorrhage are among the most frequent complications. A considerable percentage of obstetric operations have been necessary.

Ventro-suspension is very infrequently followed by difficulty in labor. This is explained by the stretching or breaking of the fibrous suspensory ligaments which support the uterus from the abdominal wall.

New Growths of the Uterus.

1. Fibromyoma. Fibromyomata are not common causes of trouble in labor. It is impossible accurately to group the disturbances which occur in relation to the various forms of tumor met with, viz., submucous, subperitoneal, and interstitial.

The most dangerous as regards labor are those in the region of the cervix. These may lead to malpresentations and malpositions of the fœtus, to obstruction in labor, to prolapse of the cord, to adherent placenta, and to post-partum hemorrhage. Labor-pains may be very irregular, often inefficient; sometimes a tetanic condition is met with. Laceration of

the uterus may occur. Contusions and fractures of the fœtal skull may be caused. Death may occur in some cases if interference be not carried out.

In the puerperium there is increased risk of inflammation and septic infection, or, in the case of a submucous tumor, of necrosis.

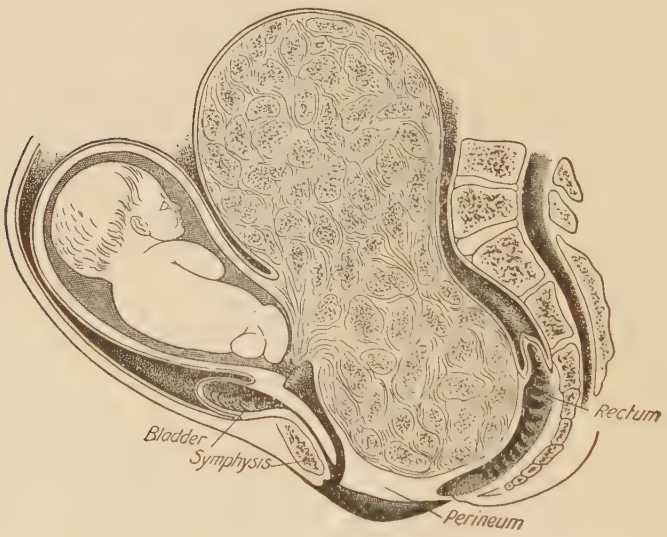
Sometimes the contractions of the uterus may displace above the brim a small tumor which had lain below it on the anterior wall.

Spontaneous enucleation of a submucous fibroid may occur during or immediately after delivery.

Diagnosis. The diagnosis is not, as a rule, difficult, save when the fibroid is on the posterior wall or projecting into the cavity of the uterus. When they can be felt they are generally easily recognized. They may be mistaken for parts of the fœtus, for twins, or for portions of placenta.

Treatment. In some cases of fibroid—*e. g.*, subperitoneal ones high up in the body—the labor may go on perfectly naturally. In cases where

Fig. 327.



Myoma uteri complicating pregnancy. (After Spiegelberg.)

there are several small fibroids or a large one high up in the wall, the pains may be weak and labor prolonged. In such a case version or forceps may be employed. Interference should be carried out early, because the risks to the mother are greater the longer the delay.

When a small tumor is felt so low down as to be a source of obstruction, it should be carefully examined, in order that it may be known whether or not it may be pushed upward. Attempts may be made to push the tumor up, the patient being in the lateral, dorsal, or genupectoral posture. Anæsthesia may be necessary to carry out this procedure. If this is impossible, the further treatment depends on the amount of contraction. It may be so slight that delivery by version or forceps may be performed;

Walcher's position may sometimes assist delivery. If greater, embryulcia or Cæsarean section is necessary. Should such a case be under observation during the course of pregnancy, the induction of premature labor may sometimes be a safe method of procedure.

Polypoidal fibroids of the cervix may be removed before or during delivery. Non-pedunculated ones of the cervix may be enucleated artificially.

Where a very large fibroid of the body or several small ones cause marked obstruction, Cæsarean section or Porro's operation should be decided upon.

In all cases in which delivery is effected through the vagina the greatest care must be exercised in the treatment of the third stage. The placenta may be adherent and may require separation. Hemorrhage may be profuse, from the imperfect contraction and retraction of the uterus, or from the opening of vessels in the capsule of a submucous fibroid. The hot intra-uterine douche must be used, as well as hypodermic injections of ergotin. The best method of controlling hemorrhage, however, is to pack the uterus and vagina with sterilized iodoform gauze. This may be left *in situ* for three or four days, and then may be renewed if necessary.

If a submucous tumor tends to become enucleated it should be removed early, in order to diminish the risk of necrosis and suppuration.

It is interesting to note that uterine fibroids often get smaller and sometimes disappear after labor.

2. **Carcinoma of the Cervix.** This condition may be found at full time, and may be a cause of trouble in labor. Sometimes, if the disease be early and localized, the labor may go on naturally. If the cancer be advanced and infiltrating surrounding tissues, and the case be left to nature, the pains may be intermittent for days, the patient getting weakened, and the child usually dying. Rupture of the cervix may occur, leading to bad hemorrhage or to sepsis.

Treatment. If the case is observed during early pregnancy in the localized state of the new-growth, total extirpation of the uterus by the vagina may be carried out. Later in pregnancy premature labor may be induced and amputation of the cervix or extirpation of the uterus afterward carried out, or abdominal extirpation of the uterus may be performed.

At full time, when the cervical cancer is not too extensive, some prefer to perform embryulcia, if a living child cannot be delivered. Opinion is, however, tending more to favor the performance of Cæsarean section in all cases where the disease is at all marked. But whenever there is a chance that the cancer may be entirely removed, Porro's operation should be carried out.

Dührssen has recommended the vaginal route for certain cases. The uterus is drawn down, the bladder dissected from its wall and pushed upward, and an opening made into the uterine cavity, through which the fœtus is extracted. The uterus is then removed.

Stenosis of Vagina and Vulva and Rigidity of Tissues.

Sometimes the vagina may be double, or have longitudinal or transverse septa. Rarely, it may be markedly atresic.

Treatment. Septa should be divided. An atresic portion may be dilated if it be not too extensive. Incisions may be necessary. But sometimes embryulcia or Cæsarean section may be indicated.

The hymen may be a cause of obstruction and may require incision or removal.

The vagina and vulva may be narrow and tough in elderly primiparæ, in very muscular women, and in conditions of cicatricial contraction after previous injury.

Treatment. Hot douches, emollients, and warm sponges serve somewhat to soften the parts. Dilation may be promoted by means of artificial dilators—*e. g.*, Barnes's or Champetier de Ribes's bag.[1] If the perineum is so rigid that it will not stretch well, and if a rupture is feared, episiotomy should be carried out with scissors, a cut being made through the edge on each side a short distance from the middle line. This procedure saves the risk of a tear into the anus. The cuts can be closed after delivery, if they are large. It is to be remembered that labor may be expedited in a case of rigid perineum if the patient be placed in Walcher's position.

Where cicatrization of the vagina does not yield to hydrostatic dilation, accompanied with superficial incisions sufficient to permit of delivery by version or forceps, Cæsarean section is necessary.

Swellings of the Vagina and Vulva.

Hæmatoma. This condition may be found in the labia, the perineum, or the vaginal walls. Though it mostly occurs after labor, it may be a cause of delay in labor. Sometimes it may form between the delivery of the first and second child in the case of twins. If the mass be large enough to obstruct delivery, it should be incised and cleared out, to allow of the passage of the fœtus. Afterward, if there be slight bleeding, the cavity should be packed with iodoform or chinosol gauze. If, however, the hemorrhage be severe, it may be necessary to close the cavity from side to side with a series of sutures, and to keep up pressure on the surface by means of a pad and bandage. In the case of a small mass delivery may be effected by means of forceps, incision not being necessary.

Œdema of the Vulva. This condition may be due to heart or kidney disease, or to delayed labor. The œdematous parts are apt to tear, and may become gangrenous afterward. Puncture or incision may be necessary, but only when absolutely unavoidable, owing to the risk of sepsis or gangrene. This procedure must be carried out with strict asepsis. Episiotomy may be necessary to save rupture.

Varicose Veins of Vulva. These very rarely interfere with the passage of the head through the vulva. They may rupture or be so bruised as to slough afterward.

[1] These dilators must not be overdistended, lest rupture of the vagina be caused.

Labial Abscess. If this is large enough to obstruct labor, it may be opened, scraped out, swabbed with iodized phenol, and stuffed with iodoform or chinosol gauze.

Solid Tumors of the Vagina and Vulva. Fibromata and fibromyomata may occur and may interfere with delivery. The bruising of the tumor may lead to after-gangrene.

TREATMENT. If these tumors are not recognized until labor comes on, it may be possible to remove them by enucleation or by amputation of the pedunculated forms. Where this is not considered advisable, forceps may be used if the vagina is not too much contracted. There is danger of causing after-sloughing of tissues if there be a prolonged use of the forceps. Rarely embryulcia or Cæsarean section may be necessary.

Cysts. These may obstruct labor. Puncture is usually sufficient to promote delivery. A pedunculated cyst may be removed easily during labor.

Enterocele. Vaginal enterocele may be either anterior or posterior. The latter is most common. The hernial condition may obstruct labor when the bowel is distended with gas or with feces. The long-continued pressure of the head may lead to a rupture of the sac, or may seriously bruise the bowel.

TREATMENT. The patient should be placed in the genupectoral position and the hernia reduced. If this is not possible, owing to the low position of the presenting part of the fœtus, or to adhesions, the child should be delivered rapidly with forceps. Should rupture of the sac occur the intestines should be cleansed and returned, and a repair operation be performed on the posterior vaginal wall.

If the hernial condition be a very large one, Cæsarean section may be justifiable.

Distended Rectum or Colon. Fecal accumulation may delay labor by interfering with the powers and by obstructing the passages. The bowel must be cleared out with enemata or by repeated flushings by means of a funnel and tube. Sometimes it is necessary to scoop out the masses, and for this it may be necessary to anæsthetize the patient.

Sometimes this distention of the rectum may be associated with the condition known as *anus vaginalis*, in which the anus is placed too far forward.

Cancer of the Rectum, if extensive, may be such an obstruction as to lead to Cæsarean section.

CONDITIONS OF THE BLADDER.

Distension. This is a very common cause of delay in labor. The urine should be removed with a long, soft catheter. Sometimes this is impossible, and suprapubic aspiration must be carried out.

Cystocele or Colpocystocele. This condition may obstruct labor. It may be mistaken for an impacted cervix, for the bag of membranes, for the caput succedaneum, or for a tumor.

TREATMENT. The urine should be drawn off, care being taken to pass the catheter downward and backward. The prolapsing part should be gradually pushed up above the advancing head. It may be necessary to deliver the child with forceps, the sacculation being held up by an assistant.

Vesical Calculus. If the calculus be very small, labor may go on naturally without causing any trouble, but if it is of any size it is apt to be very painful, to obstruct delivery, and to lead to injury of bladder and vaginal walls. If discovered early in labor it may be pushed above the symphysis and removed after labor, in the case of a small one. Some, however, think it best to remove it by dilation of the urethra. If the stone be too large to be removed in this way, it should be extracted through a mesial incision in the anterior vaginal wall and base of the bladder. After labor the incision can be closed.

Tumors of Neighboring Structures.

Ovarian Tumors. Ovarian tumors may complicate labor in various ways. If of large size they may interfere with the powers and may obstruct the passages. They may also cause malpositions and malpresentations. Small tumors are serious causes of obstruction when they lie in the true pelvis. Labor may lead to rupture of the tumor when it is cystic, and this may be followed by intra-peritoneal hemorrhage or peritonitis; or the tumor wall may be much bruised and inflammation and adhesion may result. Twisted pedicle and occlusion of the bowels are sometimes caused. Rupture of uterus, vagina, or rectum may occur.

Diagnosis. This may be difficult in some cases. The tumor may be mistaken for a fibroid or for a blood or inflammatory exudation when it is situated within the true pelvis. When it is cystic and fluctuation can be made out by vaginal examination, the diagnosis is easier.

When the tumor is above the brim and is not situated behind the uterus it may be felt distinct from the uterus, and may be moved unless impacted or fixed by adhesions. The abdomen is exceptionally distended, and the condition may be mistaken for hydramnios or twins. However, no intermittent contractions occur in the wall of the tumor, and it is thus distinguished from the uterine wall.

Treatment. If the woman has begun labor and the tumor be below the brim, an effort should be made to push it into the abdomen, anæsthesia being used, if necessary. If this fail, some authorities think it best to try delivery with forceps, if the obstruction be not too great; or, if this fail, to tap the cyst and deliver with forceps, or to employ embryulcia. Others reject these measures, and recommend abdominal section and removal of the tumor; or, in some cases, Cæsarean section and removal.

The objection to vaginal puncture is that it may be followed by danger to the peritoneum by escape of the contents, especially if it be a dermoid. If the cyst contain many loculi, puncture may do no good. Also, a mistake in diagnosis may be made, and a pyosalpinx, for instance, might be opened.

When the cyst is above the brim delivery may usually be effected by version or forceps. It must be remembered, however, that as a result of labor serious complications may arise—*e. g.*, rupture of the cyst, hemorrhage, gangrene, peritonitis. The patient should, therefore, be examined and watched with great care and the tumor removed at an early date. If any of the above-mentioned complications arise, immediate removal is indicated.

Other Tumors of the Soft Parts. Broad ligament, tubal, and other swellings, if of sufficient size to cause serious obstruction in labor, are best treated by Cæsarean section. A hydatid cyst should also be treated in this way.

Inguinal and Crural Herniæ. These may be forced down during labor and cause a great increase in pain and excessive straining. It may be necessary to hold the hernia back during the pains, or sometimes to anæsthetize the patient and deliver by version or forceps.

Floating Kidney. A kidney may be displaced downward and be adherent at the brim, or may be deeply placed in the pelvis, causing an obstruction and increasing the patient's suffering greatly. It may be necessary to anæsthetize and deliver by version or forceps.

Runge performed abdominal section in one case, raising the kidney out of the pelvis. Albers-Schönberg reports one case in which rupture of the uterus was caused. In another, in which the kidney lay in the pouch of Douglas, vaginal nephrectomy was carried out; this was followed by successful labor.

Tumors of the Liver. Large hydatid cysts and carcinomatous tumors may obstruct labor. Version or forceps may be necessary, or Cæsarean section.

3. ANOMALIES OF THE FŒTUS.

Malposition of the Head.

Occipito-posterior Cases.

There are two varieties: that in which the long axis of the head lies in the right oblique diameter at the beginning of labor—right occipito-posterior, R. O. P.—and that in which it lies in the left oblique diameter—left occipito-posterior. The former is the more common.

Labor is generally longer in these cases, partly because the head does not flex well on entering the pelvis, and so does not become well accommodated to it, and partly because of the long internal rotation. The pains in the first stage are often irregular and imperfectly marked.

Diagnosis. On external examination of the abdomen at the beginning of labor, the back of the fœtus is not felt through the mother's anterior abdominal wall. If the parts are lax or thin, the irregular projections of the limbs of the fœtus may be felt. The head may be palpated above the brim. The fœtal heart is heard well around in the flank between the iliac crest and the ribs. On vaginal examination the rounded head is felt through the fornices. When the cervix is opened sufficiently to allow the entrance of the fingers, the sagittal suture is felt in the line of the oblique diameter, and the posterior fontanelle is in the posterior half of the pelvis.

Mechanism. The normal mechanism in a typical case is as follows:

Flexion.
Internal rotation.
Extension.
External rotation.

Flexion goes on slowly, and consists in a movement of the occiput downward and inward from its original position near the

girdle of contact. Following this movement, the occipital end of the head reaches the sacral segment of the pelvic floor. As a result of this, according to the teaching of Berry Hart, internal rotation is brought about, the occiput being thrown or directed forward until it lies in the middle line anteriorly. The rest of the delivery proceeds as in an occipito-anterior case.

FIG. 328.

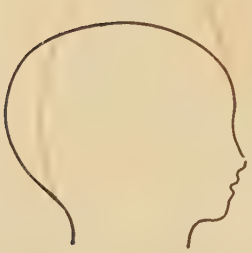


Diagram showing head unmoulded and moulded in a persistent occipito-posterior case.

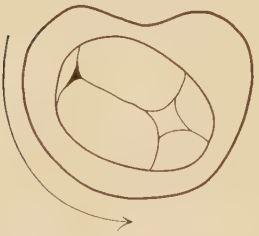
Black, unmoulded.
Red, moulded.

Abnormal Occipito-posterior Cases. 1. In some cases the head does not flex well on entering the brim, owing to a small size of the head. The sinciput reaches the sacral segment of the pelvic floor before the occiput on the opposite side, and as a result, according to Hart's law, it is rotated to the front of the pelvis, the occiput turning into the hollow of the sacrum. Clinically, we always speak of this malrotation as a rotation of the occiput to the back; but in reality, according to Hart, the essential feature is the anterior rotation of the sincipital end of the head.

The head may now remain in this position, which is termed "Persistent Occipito-posterior" or the "Face to Pubes" case. (Fig. 331.)

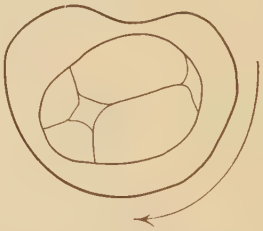
But natural expulsion may take place, the face passing under the symphysis and the occiput over the perineum. This is accomplished with difficulty, and requires very strong pains, lax maternal parts, and not too

FIG. 329.



Right occipito-posterior position of head. The arrow shows the direction of the long internal rotation made by the occiput in delivery.

FIG. 330.



Left occipito-posterior position of head. The arrow shows the direction of the long internal rotation made by the occiput in delivery.

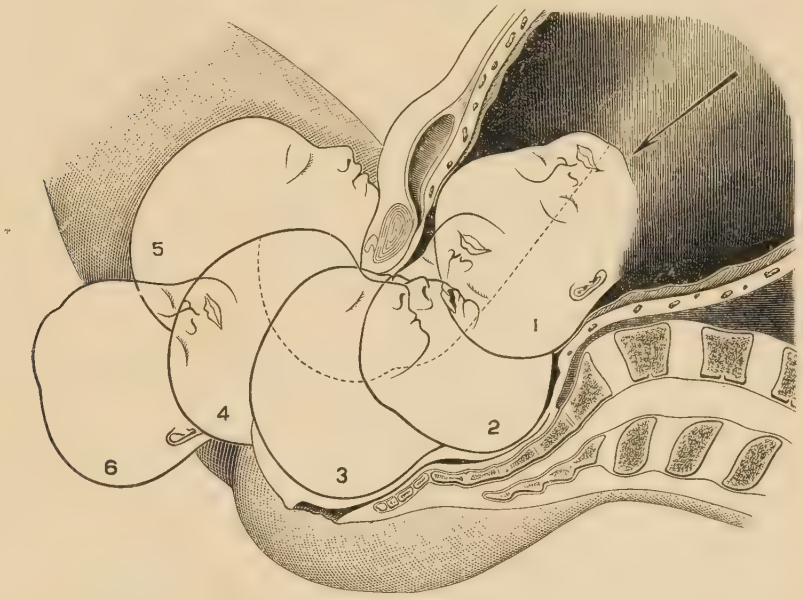
large a head. The perineum is generally badly torn. The head flexes well before it passes through the outlet. After the birth of the head external rotation (really an internal rotation of the shoulders) occurs, and the body is born.

The *head-moulding* in these cases is as follows: The occipito-mental and occipito-frontal diameters are much shortened, the suboccipito-bregmatic being lengthened greatly.

2. In some cases, owing to the disproportion between the occipital end of the head and that part of the brim in relation to it, flexion is prevented, and the head may enter the brim in an extended position, giving a brow or face presentation.

3. In another set of cases the head may enter the brim poorly flexed, and on reaching the pelvic floor may rotate only partially, remaining fixed in its long diameter, being in the transverse of the pelvic cavity.

FIG. 331.



Faulty mechanism in a right occipito-posterior case. The occiput is shown rotating to the back. (After SCHULTZE.)

MANAGEMENT OF LABOR. The case should be carefully watched and frequent examinations should be made to determine whether or not flexion is taking place to a sufficient extent. If the mechanism goes on satisfactorily, the management is the same as in an occipito-anterior case.

When flexion takes place badly it should be promoted, the sinciput being pushed up during the pains. This is best accomplished if the patient be placed in the genupectoral posture.

If this be not successful, some authorities recommend that the woman be anæsthetized, the hand passed into the cervix and the head markedly flexed by pressing up the sinciput. The anæsthetic should then be stopped and the head kept flexed until pains return, forcing it into the brim. Should extension again be established, the following methods may be adopted: The fœtus may be turned and delivered as a breech case; or the head and trunk may be rotated by the hand until the occiput is anterior, and then may be delivered with forceps; or forceps may be at once applied while the occiput is posterior. Most physicians employ the latter method.

APPLICATION OF FORCEPS IN A HIGH OCCIPITO-POSTERIOR CASE. The blades are applied in the ordinary manner—*i. e.*, right and left *qua* the pelvis. As the head is drawn into the cavity rotation tends to occur.

As a result of this the blades are so altered as to be ill-adapted to the pelvic curve, and they should, therefore, be removed as soon as the head is well through the brim. The case may then be left to nature, or the forceps may be reapplied.

Recently Milne Murray has introduced axis-traction forceps for these cases to allow of continuous extraction of the head in spite of the rotation which occurs. The main feature which permits this is the lessening of the curve of the blades.

Application of Forceps when the Head is Low in the Pelvis. When the occiput has not rotated to the front or has only partly rotated, the forceps will grasp the head obliquely or antero-posteriorly. As traction proceeds the head tends to rotate. If this is marked, the blades should be removed and reapplied. Between tractions the handles should be separated, because sometimes the occiput tends to turn to the front spontaneously.

When the occiput is in the hollow of the sacrum the sinciput should be kept well pushed up, in order to promote flexion and to allow head-moulding to occur. Then forceps should be applied and delivery brought about, the patient being placed in Walcher's position the better to protect the perineum. As the head emerges it should flex, the root of the nose pivoting under the pubic arch.

If necessary, the perineum should be incised on each side of the middle line to prevent a central rupture.

Face Presentations.

Frequency. Face presentations are not common. Various statistics are given, from 1 in 200 to 1 in 497.

Positions. The chin is the denominator and the positions are in order of frequency:

Right mento-posterior, R. M. P.
Left mento-anterior, L. M. A.
Left mento-posterior, L. M. P.
Right mento-anterior, R. M. A.

Some authorities believe that left mento-anterior positions are more frequent than right mento-posterior.

Etiology. It is best to regard face presentations as altered vertex presentations. They very rarely exist before labor sets in, and, as a rule, they develop only as labor proceeds. The causes are varied; they may be tabulated as follows:

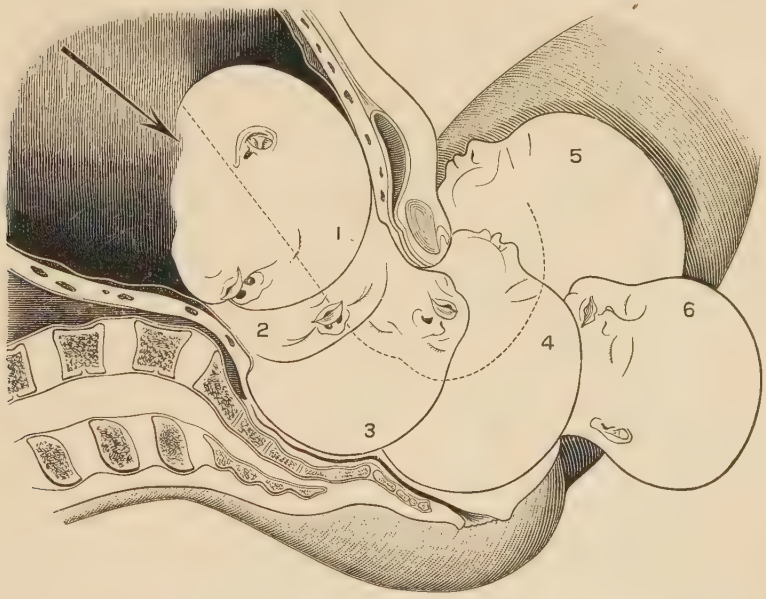
1. Enlarged neck or thorax—*e. g.*, due to tumor.
2. Coiling of cord around neck.
3. Folding of arms under chin.
4. Excessive mobility of fœtus.
5. Small size of fœtus.
6. Excessive liquor amnii.
7. Obliquity of uterus.
8. Sudden escape of liquor amnii.
9. Flat pelvis.
10. Certain conditions of occipito-posterior cases, in which there is a tight fit at the brim.

By some, dolichocephalic head is given, but it is doubtful if this shape ever exists in utero sufficiently marked to bring about a malpresentation. It is found after delivery in face cases, but the shape is due to the head-moulding.

The factor in changing a vertex to a face presentation is evidently extension, and the student may easily understand how the above causes may induce this change.

Diagnosis. The examination of the mother's abdomen reveals, in many cases, nothing different from what is found in a vertex presentation. If the abdominal wall be lax, however, it may be possible to feel the furrow between the back and the occiput, owing to the extension of the head. There is also a lack of application of the body of the fœtus to the uterus and abdomen. The bulging of the occiput at the side may be felt. On vaginal examination early in labor the rounded head felt in vertex cases is wanting. The fornix is high up and somewhat irregularly flattened across.

Fig. 332.



Mechanism of labor in a face case. Right mento-anterior. (After Schultze.)

When the cervix is somewhat dilated, forehead, nose, malar processes, and mouth may be distinguished. If much of a caput succedaneum has formed over the face, it may be mistaken for a breech; the mouth being mistaken for the anus, the nose for the coccyx, the malar processes for the ischial tuberosities, and the cheeks for the nates. Care must be taken not to injure an eye in making the examination.

Prognosis. Labor is slow. The first stage is delayed because the head does not fit so well in the lower uterine segment as in a vertex case, and does not allow of the formation of so good a bag of waters. Anterior cases—*i. e.*, those in which the chin is in front, are better than posterior, and the labor is quicker.

In posterior cases malrotation may occur, usually requiring interference; the skull is compressed against the pubes. The maternal risk is not greatly over the normal; the risk to the child, compared with vertex cases, is computed to be as 13 is to 5. There is more danger of laceration of the perineum.

Mechanism. *Normal.* (*a*) In the most common anterior case—L. M. A. (this is simply an R. O. P. case in which extension of the head has occurred). At first extension of the head goes on slowly, and it passes through the brim with its vertical diameter in relation with the inlet. As the fœtus is pushed down it is evident that that part of the head which first reaches the sacral segment of the floor is the chin. It reaches the anterior part of the left half of the segment, and, in accordance with Hart's law, is rotated forward to the middle line under the symphysis. When internal rotation is complete, flexion follows. The mouth, nose, eyes, and forehead appear successively. Then the vertex comes over the perineum while the chin slides forward under the symphysis. Finally the occiput sweeps over the perineum. Afterward external rotation or restitution occurs—in reality a rotation of the shoulders—and the body is next delivered.

(*b*) In the most common posterior case—R. M. P. (this is an L. O. A. in which extension has occurred), at first extension of the head occurs. Long internal rotation then takes place, whereby the chin is brought to the front under the symphysis. The rest of the labor is the same as in the case of L. M. A.

Abnormal. (*a*) In a large pelvis, sometimes, or in cases where the fœtus is small, the head may be pushed through the pelvis without any special mechanism.

Its long diameter may be found in relation with any diameter of the pelvis. In the flat rachitic pelvis it usually passes with its long diameter in the transverse. These abnormal deliveries are most favored by death of the fœtus, when its tissues become more lax.

Fig. 333.

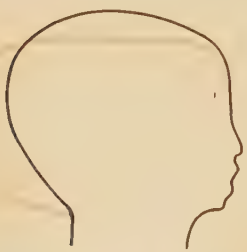


Diagram showing head unmoulded and moulded by labor in a case of face presentation.

Black, unmoulded.
Red, moulded.

(*b*) Sometimes, in mento-posterior cases, abnormal internal rotation occurs, so that the chin, instead of being carried to the front, is turned to the hollow of the sacrum. According to Hart, the explanation of this condition is as follows: It only occurs when the pelvis is very large or the head small. Extension of the head is imperfect, and the chin does not strike the sacral segment on its own side. It is the sinciput which strikes the opposite segment, and is, therefore, rotated to the front. In other words, that which we describe clinically as a rotation of the chin to the back is really a forward movement of the sinciput.

This condition is a bad one. It is very rare that natural delivery follows, and then only when the head is very much smaller than the pelvic cavity. It is apt to become arrested, being then known as a "persistent mento-posterior" case. The reason of this is evident. The chin is jammed in the curve of the sacrum, and if the head is to be born

the coccyx must be excessively bent back, the sacro-sciatic ligaments and perineum greatly stretched, and the cranial vault greatly flattened.

Head-moulding. After an ordinary face delivery the vault of the head is seen to be flattened, the supra-occipital being pushed backward and the convexity of the frontals increased. The transverse, occipito-frontal, and occipito-mental diameters are increased, the suboccipito-bregmatic lessened. (Fig. 333.)

The caput succedaneum is found on the face: in mento-posterior cases in the upper malar region and region of the eye (thus, in the R. M. P. case, on the right side of the face); in mento-anterior cases in the lower malar region, about the angle of the mouth (thus in L. M. A., on the left side of the face). In other words, the caput is formed over that part which has been especially placed in relation to the deficiency in the anterior pelvic wall below the pubes. The skin may be greatly discolored. The eye may be closed for some days, or the mouth may be incapable of suckling for a short time.

Management. The bag of membranes should be preserved as long as possible, because the face is so poor a dilator. Sometimes the case may be left to nature—*i. e.*, when the woman is a multipara who has had easy labors, when the pelvis is roomy and the soft parts easily dilatable, when the pains are good, and when the chin is anterior.

Internal rotation may be favored by the turning of the chin forward with the fingers during the pains.

In posterior positions of the chin, or in anterior positions when any abnormal condition exists, interference is necessary.

Different procedures are recommended. At first the patient should be anæsthetized and an effort made to bring about a vertex presentation by external manipulation through the anterior abdominal wall. But if this procedure fail, the following means may be tried.

When the chin is posterior an attempt may be made, first of all, to restore a vertex presentation by pushing up the sinciput. When the chin is anterior this would only result in an occipito-posterior position, and, therefore, it is not to be recommended. If restoration is carried out and the vertex engages, the case may be left to nature; if engagement does not soon take place, forceps should be applied.

If restoration of the vertex presentation be not possible or advisable, delivery by version may be employed. If version be impossible or dangerous, owing to the conditions present, forceps may be used in anterior positions. This is a difficult and dangerous mode of treatment, and is only to be undertaken as a last resort. The grip of the blades is bad for the child, and also for the mother, on account of the width between them. When the chin is posterior they should not be used at all, because if the head passes the brim, it tends to move, so that the chin goes into the hollow of the sacrum.

When delivery is impossible by these procedures, embryulcia is justifiable.

When the head has passed the brim and tends to be delayed, in spite of the efforts to promote extension and internal rotation, there is always danger to the child from the tension on the vessels of the neck and from the pressure against them, endangering the cerebral circulation. In such a case forceps should be employed. It must be used carefully, as

there is great risk that the blades may press dangerously on the nerves and vessels of the neck.

When the chin has rotated into the hollow of the sacrum, efforts should be made to rotate it to the front, the patient being anæsthetized, if necessary. If this is impossible, the usual plan is to attempt delivery with forceps. When the head is passing the perineum the latter should be incised on each side to lessen the risk of bad laceration, and the patient should be in Walcher's position. As soon as the chin is born the rest of the head should be brought out by flexion. If this method of delivery be impossible, or if the child be dead, embryulcia may be performed. Recently, however, owing to the success of symphysiotomy, it is strongly recommended that in a persistent mento-posterior case this operation should be performed before delivery is attempted with forceps. There is far greater chance of getting a living child, and the risk to the mother is not much increased.

Brow Presentations.

Frequency. Brow presentations are very much less frequent than face cases. They are only a half-way stage in the development of the latter, the head being only partially extended. The most frequent position is that in which a vertex L. O. A. has been changed; the next most frequent that in which a vertex R. O. P. has been altered.

Etiology. The causes are the same as in the case of face presentations.

Diagnosis. By external examination the condition cannot be made out. When labor has begun and the fingers can be passed within the cervix, the root of the nose, the margins of the orbits, and, possibly, the anterior fontanelle, may be felt.

Mechanism of Labor. 1. In certain cases where the child's head is rather small a special mechanism may take place. The head passes through the brim in the extended position, the occipito-mental diameter having been diminished in length. The brow descending to the pelvic floor is then rotated to the front until it lies opposite the vulva, the face being behind the pubes and the chin at its upper margin; the occiput lies in the hollow of the sacrum. Flexion then occurs, the cranial vault sweeping over the perineum; the nose, mouth, and chin afterward passing under the symphysis. The body is then born, rotation taking place for the delivery of the shoulders.

2. Sometimes, when the pelvis is very large or the child small, the latter may be pushed through the pelvis without any mechanism.

3. A natural change in the presentation may take place to a vertex or to a face.

Head-moulding. After the mechanism described above, the head is characteristically altered. The caput succedaneum reaches from the root of the nose to the anterior fontanelle, the forehead is somewhat perpendicular, and the parietal and occipital bones slope downward and backward. On profile the head has thus a somewhat triangular shape. (Fig. 334.)

In a case which has begun as a brow and finished as a face, the head is dolichocephalic, with a marked caput succedaneum on the forehead and one on the face.

Management. On diagnosing a brow case early in labor the sinciput should always be pushed up, in order to bring about an engagement of the vertex, pressure being made during the pains. The case may then be left to nature, or forceps may be used. If the vertex presentation cannot be produced successfully, and if the case be one in which the brow position is posterior (*i. e.*, in which originally the occiput was to the front), delivery by version should be proceeded with. It is not wise to change the presentation to that of a face in this condition, because the chin will be made to lie posteriorly. If, however, the case be one in which the position is anterior, instead of performing version some prefer to bring about extension to the head, and so to get a face presentation, the chin being to the front. The case may then be left to nature, or may be treated in the various methods recommended for face presentations.

Fig. 334.

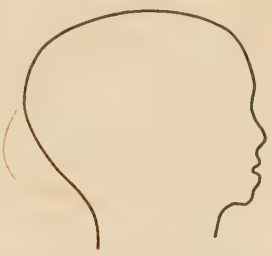


Diagram showing head unmoulded and moulded by labor in a case of brow presentation.
Black, unmoulded.
Red, moulded.

When these procedures cannot be carried out, and labor is delayed, it may be necessary to attempt delivery with forceps, a procedure which is unfavorable both for child and mother. When this is impossible or too dangerous, embryulcia may be performed.

Now, however, it is highly probable that symphysiotomy will displace both the use of forceps and embryulcia in these cases.

When labor is delayed after the head has entered the pelvis, forceps is indicated. When malrotation has occurred and the chin is posterior, the use of forceps is difficult and dangerous, and the case must be treated practically as one of persistent mento-posterior face.

Pelvic Presentations.

Frequency. According to the statistics of Pinard, pelvic presentations occur in the proportion of one in thirty labors; excluding miscarriages and premature births, however, he finds it to be about one in sixty. In the majority of cases the breech presents; in the rest either the knees or the feet present.

The positions in order of frequency are :

Left sacro-anterior, L. S. A.
Right sacro-posterior, R. S. P.
Right sacro-anterior, R. S. A.
Left sacro-posterior, L. S. P.

The denominator is the sacrum.[1] (Figs. 335, 336.)

Etiology. The conditions favoring a pelvic presentation are excessive liquor amnii, lax uterine and abdominal walls, obliquity of the uterus, multiparity, multiple pregnancy, monstrosity, death or prema-

[1] Berry Hart objects, rightly, to the use of the sacrum as the denominator. We do not follow the sacrum in the mechanism of labor, but the hip which is nearest the front. Therefore, to keep up uniformity of description in the various mechanisms, he desires to denominate the positions in reference to the hip.

turity of fœtus, placenta prævia, contracted pelvis, tumors of uterus or neighboring structures.

Diagnosis. On abdominal examination, the head is felt in the upper part of the uterus. The fœtal heart-sounds are heard above the level of the umbilicus.

On vaginal examination, early in labor, the hardness of the head is missed through the fornices. After labor has advanced the examining fingers may recognize through the cervix, the sacrum, coccyx, and ischial tuberosities. The anus is felt as a dimple below the skin level. If the child is dead, however, it may be gaping and may project as an eminence.

Fig. 335.

Pelvic presentation. Right sacro-posterior. Feet and cord in relation to os internum. (After A. R. Simpson.)

Fig. 336.

Pelvic presentation. Left sacro-anterior position. (After A. R. Simpson.)

If the child be a male the penis and scrotum may be felt; the latter should not be mistaken for the bag of membranes. The finger should be passed into the groin, which is distinguished from the axilla by the absence of ribs. Movements of the feet are felt when the case is a footling presentation. The foot must be distinguished from the hand by the presence of the projecting heel and by the parallel toes.

The feet usually lie close together. The knee is distinguished from the elbow by the presence of the patella, by its larger size, and by the absence of the sharp olecranon.

Meconium may be distinguished in the vaginal discharge. It is abundant and tarry, not in flakes.

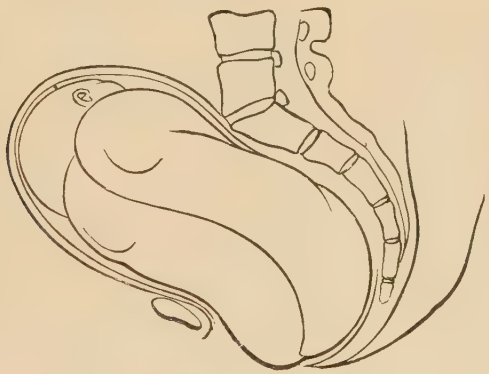
A breech may be mistaken for a face (see page 466).

Prognosis. In cases which are uncomplicated the maternal risks are no greater than in vertex cases. The risks are those of interference. They are laceration of the cervix and perineum, inertia of the uterus from too rapid delivery or from loss of blood, separation of placenta from too rapid delivery.

The risks to the child are great, the mortality being about 1 in 10. These are due to prolapse of the cord and pressure on it; early escape of the liquor amnii, which is apt to occur, because the girdle of contact does not grasp the breech as well as it does the head, and, the forewaters not being completely shut off from the rest of the liquor amnii, the membranes burst under an abnormal degree of the force of uterine contraction; partial or complete separation of the placenta from hurried delivery or prolonged compression of the placenta, leading to gradual asphyxia or to sudden death. Fractures and dislocations may be caused by interference. It is stated by Koettnitz that hæmatoma of the sterno-mastoid and torticollis are most frequent in connection with breech delivery.

Mechanism. The normal mechanism usually takes place as follows: The breech is either pushed straight down through the pelvis, or the

Fig. 337.



Passage of buttocks over perineum in a breech case. (After Barnes.)

anterior hip may descend somewhat in front of the other. This hip on reaching the sacral segment of the pelvic floor is rotated to the middle line in front, this movement being known as internal rotation. It becomes fixed at the pubic arch, while the trunk is more driven down into the pelvis and the posterior hip moves forward to the perineum, which gradually retracts over it. The anterior hip is then somewhat released from being pressed against the pubic arch, and the whole pelvis moves onward, followed by the rest of the trunk, with the lower and upper extremities, both being in an attitude of flexion. (Fig. 337.) Sometimes the lower limbs are not bent at the knees, but lie straight on the front of the body. This is less favorable, and may cause delay in labor, because the straight limbs act as splints, as Tarnier has stated, interfering with the flexing of the trunk and with its accommodation to the pelvic curve. The shoulders pass the brim, their long diameter in the transverse. The head passes flexed, its antero-posterior diameter lying in the

oblique or transverse of the brim. When it is well in the cavity rotation occurs, so that the occiput turns to the front, the face being in the sacral hollow. The face and the forehead are then born, followed by the rest of the head.

Moulding of the Fœtus. The breech is swollen. It may be only œdematous, or may present a large, dark swelling. This is generally over the anterior hip, but it may spread to the region of the genitals, and may especially affect the scrotum in the male. These signs may also be found in the knees or feet when they present.

Abnormalities in the Mechanism. 1. The breech may stick at the brim and may not engage. This is especially apt to be the case where the pelvis is contracted.

2. Having entered the brim the body may stick, no further advance being made. This condition of matters may be due to the small size of the pelvis, abnormal size of the fœtus, contraction of the cervix, or to the extended position of the limbs on the anterior surface of the fœtus.

3. The arms may be displaced upward, one or both being in front, behind, or at the sides of the head. This may be due to contraction of the cervix on the body above the pelvis of the fœtus as it descends, or to the small size of the pelvis; but it is important to note that it may follow too hurried emptying of the uterus when there is artificial delivery. Very often, when the lower limbs are displaced, the upper limbs are apt also to be displaced.

This condition causes a delay in labor, which usually requires special treatment. The life of the child is endangered from the extra risk of pressure on the cord.

4. The head may become impacted above the brim or in the pelvic cavity. This usually happens as a result of extension from too rapid delivery of the child. In other cases, where the pelvis is relatively large, and the sacrum directed toward the back, the anterior hip may not turn to the front, but the body of the fœtus passes straight through the pelvis, the shoulders passing the brim in relation with the transverse diameter. The head may descend and normal rotation of the occiput take place. But rotation may not occur, the occiput remaining in the hollow of the sacrum.

In some of the cases in which the head gets extended at the brim the chin is apt to catch above the pubes and to delay labor.

In cases, also, where the back of the fœtus is to the front the head may stick above the brim if extension occurs.

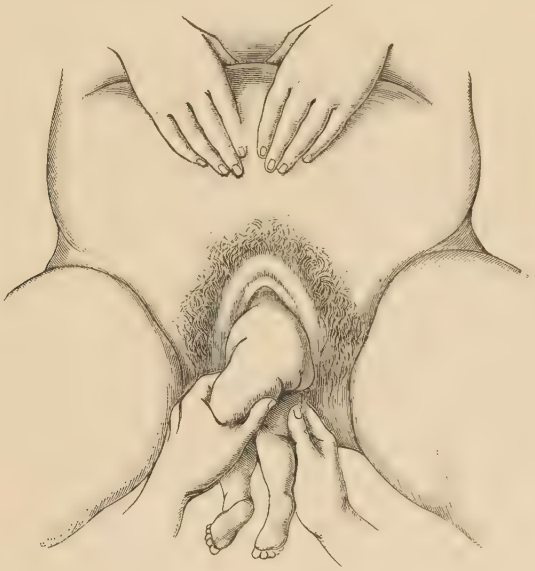
In the pelvis the head may also stick in the transverse from incomplete rotation, or in the antero-posterior diameter, the occiput being to the front, owing to extension of the head having caused the chin to get fixed in the sacral hollow.

General Management. No attempt should be made to alter the presentation, nor to interfere as long as labor progresses naturally. The physician should watch the case more closely than in a normal vertex case, and should have skilled assistance within easy reach. Dilation of the cervix may be promoted by means of hot douches. But if the membranes have been driven down as a sausage-like pouch, or have ruptured early, Champetier de Ribes' or Barnes' bag may be used, and nature may be allowed to expel the pelvis and lower extremities. When the

umbilicus appears, a piece of cord is pulled down and examined. If it is pulsating well, nature may be allowed to continue the delivery. The exposed parts may be protected with a warm cloth and held up from the perineum.

When the hands appear they may be freed. If it is found that pulsation in the cord be feeble or has just ceased, it is necessary to hasten delivery.

FIG. 338.



Delivery of child in a breech case by pressure on fundus uteri and by traction on lower limbs. (After A. R. SIMPSON.)

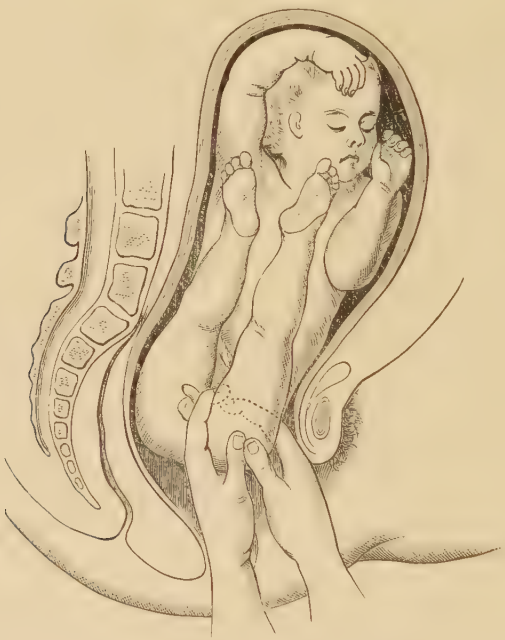
Another indication in the same direction is spasms of the body due to respiratory efforts. Speedy delivery is attained by *suprapubic pressure on the uterus*, accompanied with traction from below. Of very great importance is the former of these. The traction should be made in the axis of the pelvis, at first well backward against the perineum. (Fig. 338.)

Sometimes the cord passes between the legs of the child. In such a case a loop should be pulled down and slipped up over the posterior thigh. If this be impossible, or if the cord is wound around the body, it should be doubly ligatured and divided. Then delivery should be hastened.

MANAGEMENT IN SPECIAL CONDITIONS. *Non-engagement at the Brim.* When the breech does not engage in the brim, a lower limb should be brought down, provided there be no undue contraction of the brim. The case may then be continued by nature; but if the patient be exhausted, slow artificial delivery should be carried on by means of pressure from above the pubes and by traction from below. The latter manœuvre should be carried out as follows: The foot should be grasped between the first and second fingers. The other foot need not be brought down unless it is bent over the child's back or crosses the other leg. The limb should be drawn down slowly and by stages. When the leg is beyond the vulva

it should be covered in a warm cloth and held by the whole hand. In pulling no marked friction against the pubic arch should occur. As the child descends it should be grasped close to the mother's vulva. When the breech reaches the perineum the traction should be more in the axis of the outlet. As the lower part of the abdomen appears the other leg usually falls out. The rest of the delivery should imitate the natural process.

FIG. 339.



Delivery of child in a breech case by traction made with fingers placed in groin. (After A. R. SIMPSON.)

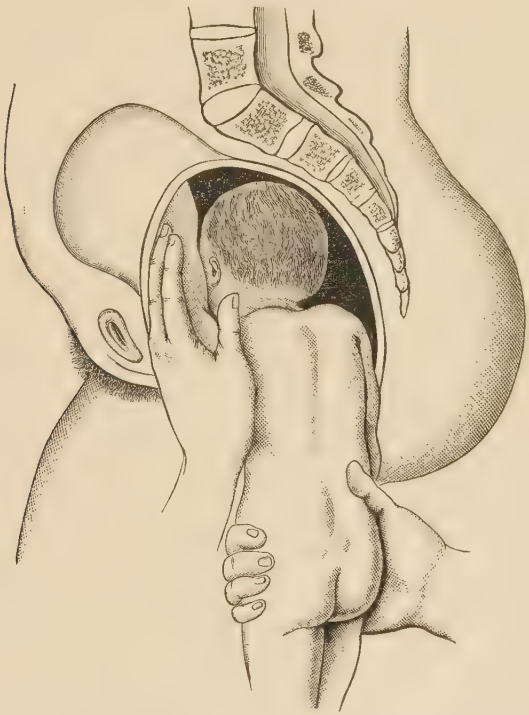
Impaction of the Breech. When, having entered the pelvis, the breech sticks, various procedures may be adopted. Here it is impossible to pull down a limb safely. The index-fingers hooked into the groin may be sufficient to promote descent by traction. (Fig. 339.) Better, however, is a fillet, such as a soft piece of silk cloth. An aseptic gum-elastic catheter threaded with a loop of string may be used to pass the fillet around the groin. A blunt hook is also sometimes used for the purpose of extraction, but is apt to cause injury. The line of traction should be toward the side on which the sacrum lies, in order that fracture of the thigh may be avoided.

Forceps may also be applied to the breech in such a case, though not without some difficulty.

Sometimes delivery by these means is impossible, and embryulcia is necessary, a grip being obtained with a cranioclast, or crushing of the pelvis being performed with a cephalotribe. The after-coming head should also be perforated in such a case to render its passage easier and to insure death of the child.

Upward Displacement of the Arms. (*a*) When the head is still above the brim. When the brim does not allow the passage of the head and arms, jamming occurs just about the period when the tips of the scapulæ appear at the vulva. It is then necessary to free the arms. The body of the fœtus should be pushed a little upward in order to diminish the pressure on the arms at the brim, and the child's body should be rotated until its back is directed toward one or other side of the mother. It should then be pressed well forward against the symphysis, in order that an attempt may be made to free the arm which is most posterior. The hand is passed upward into the hollow of the sacrum and the first two fingers along the side of the neck behind the posterior arm as far as the

FIG. 340.



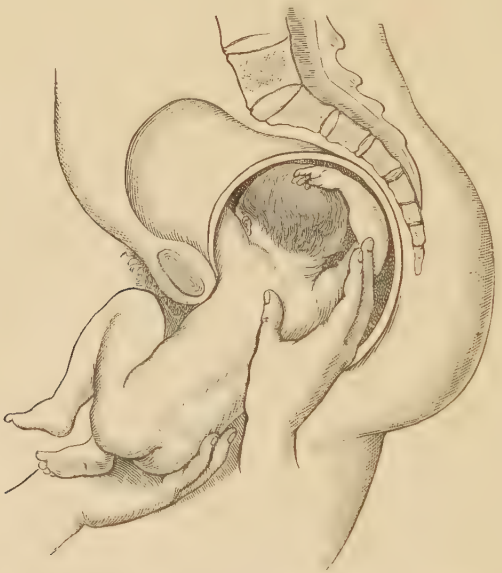
Method of freeing the anterior arm displaced upward in a breech delivery.
(After A. R. SIMPSON.)

elbow. The latter should then be swept over the face and thorax until it comes to lie within the pelvic cavity. The body of the child is then pressed backward against the perineum, and an attempt made to bring down the anterior arm by a proceeding similar to that employed in the case of the other one. (Fig. 340.) Sometimes it is impossible to get room enough to carry out this latter procedure. In such a case the body of the child should be carefully rotated by both hands placed on the thorax, the back of the child moving across the front of the mother's pelvis. The thorax should be well pushed up when this manœuvre is begun, in order to diminish the risk of dislocating the neck. By this

rotation of the back of the child from one side of the mother's pelvis to the other, the arm which was anterior is made to lie posterior, and then it may be more easily drawn down.

(*b*) When the head is below the brim. The release of the arms in this position is much easier than when placed above the brim. The procedure is practically the same. The trunk should first be drawn down as far as possible. Usually the posterior arm is first brought down; but the best rule is to release that one which is most accessible, the child's trunk being directed well toward the mother's pubes or perineum, as the case may be. (Fig. 341.)

FIG. 341.



Method of freeing the posterior arm displaced upward in a breech delivery. (After A. R. SIMPSON.)

In some cases an arm gets jammed over the back of the head between the occiput and the pelvic wall. In freeing it the fingers should be passed up over the back of the fœtus, and the arm carefully pushed around the side of the head to its own side. The elbow may then be drawn down over the face and thorax. Sometimes the arm in such a case may be released from its dorsal position by rotating the body in the opposite direction from that which caused the trouble.

In all these manipulations on the arms there is danger of dislocating the shoulder-joint, of separating the epiphysis at the upper end of the humerus, of fracturing the humerus, clavicle, or spine of the scapula, or of injuring nerves. The traction should, therefore, be made in the bend of the elbow.

In cases where this method fails, division of the clavicle may be performed—cleidotomy—to diminish the size of the shoulder-girdle.

Constriction of the Head by the Uterus. Sometimes the retraction ring of the uterus may grasp the head tightly; sometimes the cervix may be closely retracted on the neck. This condition greatly endangers the life

of the child, and delivery must be rapid. The patient should be deeply anæsthetized, and traction made on the shoulders and mouth, or forceps should be applied.

Impaction of the Head. This may take place at the brim or in the pelvis. It may be due to the large size of the head or small size of the pelvis, or to some other form of obstruction. It may also be caused by the extension of the head when there is a want of suprapubic pressure. Generally, however, it is due to extension of the head, brought about by traction on the fœtus unaccompanied with suprapubic pressure.

The methods of delivery employed in these cases are:

1. Manual Extraction. (*a*) *By the Smellie Grasp.* The body of the child is covered in a warm cloth and is placed on the flexor aspect of the physician's forearm, the legs hanging down, one on each side. The fingers of this hand are passed into the vagina, the first and second fingers being placed in the fossæ on each side of the child's nose. The fingers of the other hand are then passed up over the back as far as the occiput. By pulling down with the fingers that are on the face, and pushing up with those of the other hand, the head is flexed. Then, by raising the trunk, the head is born and the face is delivered over the perineum.

Fig. 342.

Prague grasp.

(*b*) *By the Prague Grasp.* Some physicians prefer this grasp. One hand grasps the feet, by which the body can be drawn well back over the mother's perineum. The fingers of the other hand are hooked over the shoulders, and then traction is made downward by both hands, the body being gradually carried toward the pubes as the face is drawn over the perineum. (Fig. 342.)

(*c*) *Smellie-Veit or Mauriceau Method.* This is the combined method of traction on the lower jaw and shoulders. The first two fingers of the hand that is in relation to the anterior aspect of the child are placed in the mouth, while the fingers of the other hand grasp the shoulders. The child is first drawn downward, and then the body is carried toward the pubes, while the face sweeps over the perineum. (Fig. 343.)

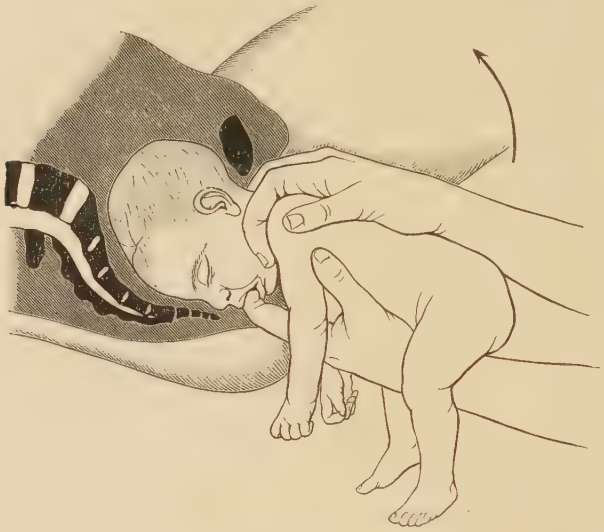
Care must be taken not to fracture or dislocate the lower jaw.

(*d*) *Wigand-Martin Method.* One hand is used with one or two fingers caught in the child's mouth to maintain flexion of the head, while the other presses the head down from above the pubes. (Fig. 344.)

2. Forceps Extraction. When the foregoing methods fail, forceps may be used. They are chiefly serviceable when the perineum is very rigid and when the head is arrested at the brim. In applying the blades the body of the fœtus should be carried well against the pubes. When

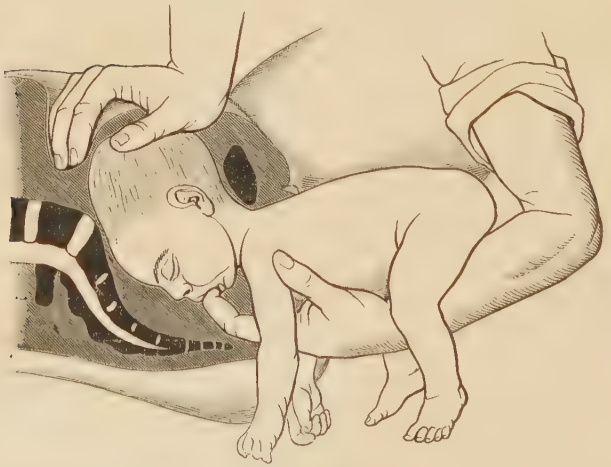
the occiput is to the back they will lie under the back of the child; when it is to the front they will lie under the abdomen.

FIG. 343.



The Smellie-Veit method of extracting the after-coming head. (DÖDERLEIN.)

FIG. 344.



The Wigand-Martin method of delivering the after-coming head. (DÖDERLEIN.)

3. DELIVERY AFTER EMBRYULCIA. In cases in which the head cannot be delivered by any of the above methods, reduction of the head by perforation is necessary. This may be done through the skull or through the base of the mouth.

Malrotation of the Head. Sometimes in the pelvis the head stays with its long diameter in the transverse, or with the occiput in the hollow of the sacrum. In these cases it is best to hold the head and trunk firmly by the Smellie grasp and to rotate them so that the occiput comes to the front, delivery being continued as already described.

Transverse Presentations.

Frequency. Various statistics are given, varying from 1 in 150 to 1 in 300. It might be generally stated that less than ½ per cent. of all cases of labor present transverse presentations.

Causes. The causes are those of malpresentation in general—*e. g.*, excess of liquor amnii; prematurity of labor; death of the fœtus, by which its tone is lost; changes in the shape of the fœtus by disease—*e. g.*, hydrocephalus; malformations and monstrosities; multiple pregnancy; irregular contractions of the uterus; tumors of the uterus; tumors of parts near the uterus; uterine malformations; placenta prævia.

Fig. 345.

Transverse presentation. Dorso-anterior, head on left side, arm prolapsed. (Farabeuf.)

Varieties. Any part of the body of the fœtus may present; usually it is the shoulder, sometimes the hand or elbow, rarely the trunk. The long axis of the trunk is very rarely transverse; it is usually obliquely placed in relation to the long axis of the uterus.

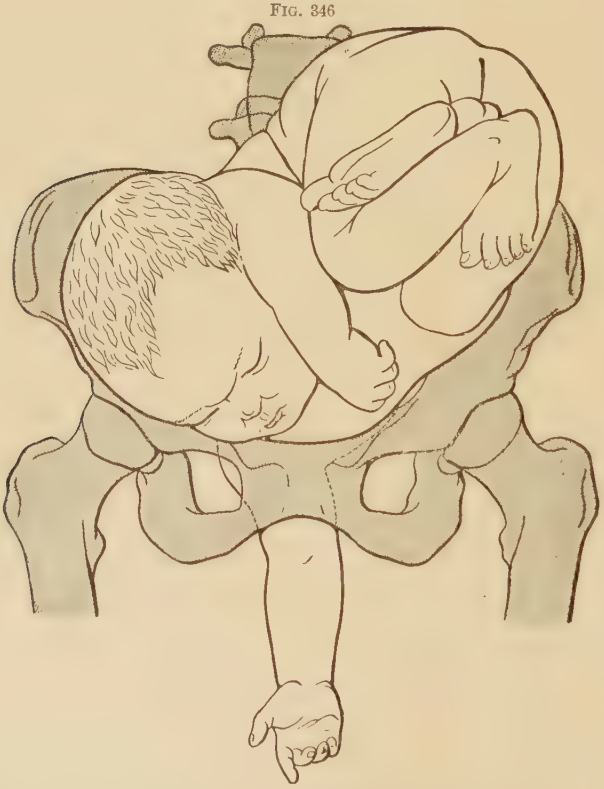
Positions. Attention need be paid only to the shoulder cases. The nomenclature employed differs in different countries. By some the acromion process is used as the denominator, by others the spine of the scapula. Certain writers prefer to make use of no denominator whatever. It is, indeed, quite sufficient to classify the positions as follows:

Dorso-anterior:
Head on the right side.
Head on the left. (Fig. 345.)
Dorso-posterior:
Head on the right side. (Fig. 346.)
Head on the left.

The dorso-anterior position, the head being on the left side of the mother, is the most frequent, and to it we will particularly allude in describing the mechanism of labor.

Diagnosis. External abdominal examination reveals the unusual shape of the abdomen. The normal regular prominence of vertex and

Fig. 346



Transverse presentation. Dorso-posterior, head on right side, arm prolapsed. (Farabeuf.)

breech cases is absent. The regular pyriform shape of the uterus is wanting. It is felt to be moulded somewhat obliquely or transversely by the fœtus. The head lies usually in an iliac fossa. The back is made out if it be to the front, or the irregularities of the limbs if they are

anterior. The fœtal heart-sounds are heard below the umbilicus in a dorso-anterior position, being conducted along the back of the fœtus.

If labor has been delayed and the uterus has been active, there may be an abnormal thinning and stretching of the lower uterine segment, so that the fœtal parts may be felt very distinctly just above the symphysis; and, higher up, the thickness of the retraction ring, where the lower uterine segment of the body of the uterus joins the upper, may be made out.

On vaginal examination early in labor the presenting part is usually very high, the vaginal fornix being somewhat flattened. The lower uterine segment is imperfectly filled, and the cervix may be felt hanging loosely. As labor proceeds the bag of membranes tends to protrude into the vagina in a sausage form and to be ineffective as a dilator. It tends to rupture early, and the cord also tends to prolapse. When the fingers can be passed into the cervix the shoulder may be recognized by the three bony ridges, clavicle, humerus, and spine of scapula running toward a central spot. A finger may be passed into the axilla, and the ribs felt, thus distinguishing it from the groin.

Sometimes the elbows or hand may be distinguished. The diagnosis of these from knee and foot is given on page 454. To know which hand is prolapsed, it is best to shake hands with it, and thus to identify it.

Prognosis. In cases left to nature the risk both to mother and child is very great. The risk may be increased by the causes of the malpresentation. As artificial delivery is now the rule in these cases, the prognosis is modified by and dependent upon the nature of the operative interference. The longer labor is allowed to proceed before treatment is carried out, the greater is the danger to the mother.

The chief risks to the mother are exhaustion, rupture of the uterus, the results of operative interference, and after-inflammation. We have already referred to the great thinning and stretching of the lower uterine segment in a delayed transverse case; it is this part which is most apt to be ruptured.

Methods of Spontaneous Delivery. 1. *Spontaneous Version.* This is the change by which nature alters the presentation from the transverse to that of the head or breech, the delivery then taking place according to the new presentation. This is most apt to occur in multiparæ whose uterine walls are lax. It is more apt to occur in the case of a living than of a dead child.

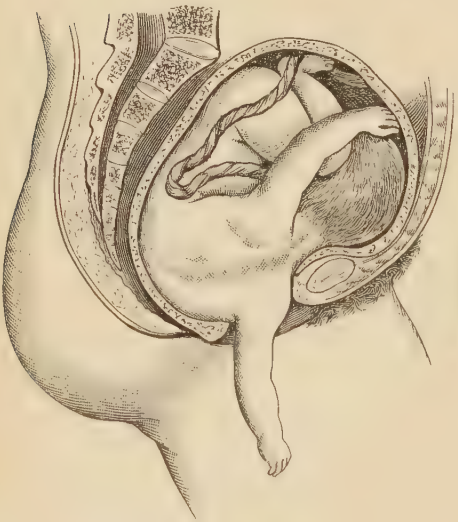
This version may occur before the membranes have ruptured as well as afterward. In the former case the pains may be weak. In the case of version after the membranes have ruptured, the amniotic fluid having partly or wholly escaped, the presenting part must be movable and not jammed in the cervix or brim, and the uterine pains must be strong. As the uterus contracts on the fœtus it is driven against the cervix, which is only partly dilated, firm, and resistant. The presenting part is gradually displaced to one side, and this is continued until version is partly or wholly completed.

(It is interesting to note that occasionally, if left to nature, a complete rotation may be carried out, one transverse presentation being substituted for another. This only takes place when there is a small child and plenty of liquor amnii.)

2. *Spontaneous Evolution.* (*a*) Most common variety (Douglas). The delivery in this variety is by a special mechanism. Certain conditions are favorable to its successful progress. The pains must be strong, the pelvis roomy, and the fœtus small. Softness and compressibility of the fœtus are particularly likely to favor this mechanism. There is no doubt, however, that it may take place where the fœtus and pelvis are of normal size. Very strong pains are the chief essential.

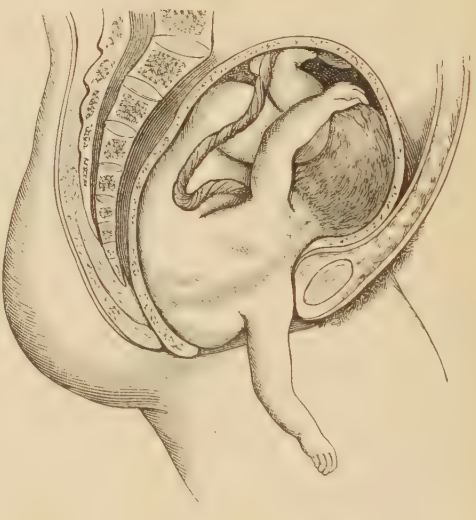
First of all, the fœtus is packed into the brim, the presenting shoulder being forced downward to the pelvic floor, and rotated forward until it rests under the pubic arch, where it sticks, the corresponding arm usually hanging outside the vulva. At this period the fœtus is so latero-flexed that the head is above the brim, lying alongside the breech, the latter being posterior. The chest is now driven down past the shoulder,

FIG. 347.



Spontaneous evolution. First stage.

FIG. 348.



Spontaneous evolution. Second stage.

then the abdomen and lower limbs, the presenting shoulder all this time pivoting on the pubic arch. Finally the head enters the pelvis and rotates, so that the occiput passes under the symphysis as its delivery is completed. (Figs. 347, 348, 349, 350, 351.)

(*b*) Rare variety (Röderer, Kleinwächter). In this form the body is delivered with doubled body (*evolutio conduplicato corpore*). The conditions which favor it are compressibility of the fœtus, small size of the fœtus, and a large pelvis. When the fœtus is dead, therefore, it can the more easily occur.

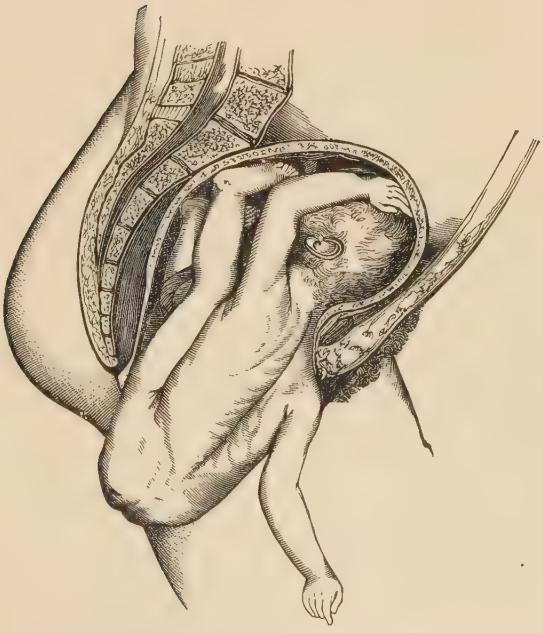
The presenting shoulder is pushed down into the pelvis, the head also being crowded into it along with the body. The arm belonging to the lowermost shoulder protrudes from the vulva; the other one lies between the breech and the head. The mass thus doubled is driven down, the presenting shoulder being delivered first, then head and chest together, and, finally, the breech and legs. (Fig. 352.)

MANAGEMENT. Transverse cases should not be left to nature. Artificial delivery must be carried out. If the condition be diagnosed before

FIG. 349.

Spontaneous evolution. Third stage.

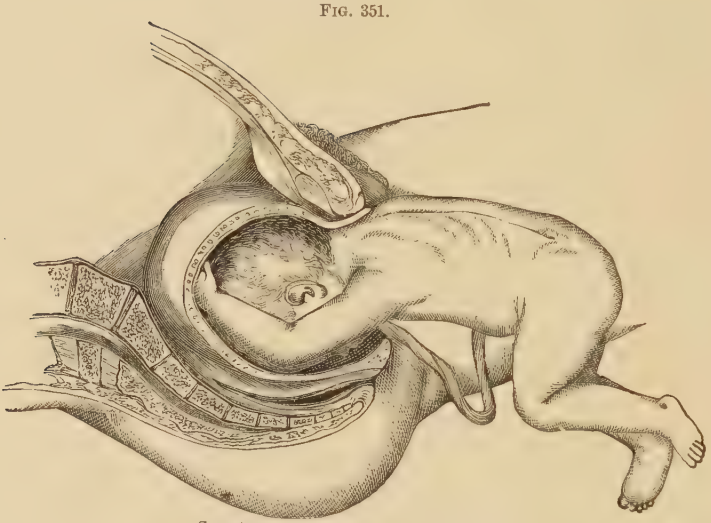
FIG. 350.



Spontaneous evolution. Fourth stage.

the membranes are ruptured or the presenting part jammed at the brim, *version* should be performed. The bipolar or Braxton Hicks's method

FIG. 351.



Spontaneous evolution. Fifth stage.

FIG. 352.

Birth of child doubled. Evolutio conduplicato corpore. (KLEINWÄCHTER.)

should be adopted when the cervix is only partly dilated, the vertex or breech being made to present. If it is a shoulder case, it is best to try to bring about a vertex presentation unless the pelvis be flat, in which case a breech presentation is best.

If the abdomen presents, a pelvic presentation should be induced.

At first external manipulations through the abdominal wall should be tried, in order to turn the fœtus, anæsthesia being employed. If this method fail, other measures must be carried out.

When the cervix is well dilated the bipolar method may also be adopted if the liquor amnii is still in utero. When it has escaped, internal or podalic version must alone be tried; before the rupture of the membranes this method may also be employed, the membranes being ruptured artificially.

How long after the escape of the liquor amnii it is feasible to perform podalic version, cannot be definitely stated. Different authorities give different limits. The student should bear in mind that the nearer to the time of rupture, the easier and safer is the procedure. It should never be

carried out when the uterus is firmly contracted on the fœtus, or when the latter is jammed into the inlet. There is always risk of rupturing the uterus. The patient should always be deeply anæsthetized in performing internal version.

In transverse cases where turning is impracticable, the child must be broken up by one or other of the following methods:

Decapitation may be carried out, when the neck is accessible, by a blunt, a serrated, or a sharp hook. The body may then be extracted, and afterward the head.

Evisceration, or removal of the contents of the abdomen and thorax, is recommended by some. This is not, however, a satisfactory procedure.

Spondylotomy, dividing the spinal column with scissors, or spondylolysis, breaking it up with a basilyst, is a better means of reducing the size of the child before extraction.

Prolapse of the Limbs.

(*a*) **In Head Presentations.** 1. One or both arms may be prolapsed in front, behind, or at the sides of the head. When one arm prolapses it usually lies close to the temporal region. The worst form is that in which the arm is across the back of the neck. Sometimes the arms are folded under the chin, bringing about a brow or face presentation (*q. v.*).

Treatment. If the condition be diagnosed before rupture of the membranes, nothing should be done until the cervix is completely dilated. Then the hand may be pushed up to allow the head alone to engage in the brim. If this fail, forceps may be applied to the head if there be no risk of catching the arm, or version may be carried out. In extracting with forceps the arm may slip up. When the case is made out only after the arm is well engaged in the brim, the head should be delivered with forceps.

2. A foot may present with the head. The line of treatment is the same. Embryulcia may sometimes be necessary.

(*b*) **In Breech Presentations.** Sometimes the hand presents. Nothing need be done. The hand may or may not slip up.

(*c*) **In Transverse Presentations.** If a foot presents, the condition is not unfavorable, for as version is the usual treatment, it can be carried out more easily. If an arm presents, it may interfere with the entrance of the physician's hand prior to the performance of podalic version. Sometimes it may be pushed up out of the way while the operator's hand is being introduced. Generally it is advisable to fasten a piece of tape around the prolapsed wrist, so that it may be drawn out of the way and prevented from ascending during the delivery of the thorax.

Anomalies of Fœtal Development.

Shortness of the Cord. This may be "absolute" when the cord has only a length of a few inches, or "accidental" when the length is reduced by coiling around the neck, body, or limbs. The latter is more frequently a cause of delay in labor. Sometimes the placenta may be detached in this condition; sometimes the cord ruptures, or is so compressed as to lead to the death of the child. Most umbilical cords break

under a weight of 8¼ pounds; some resist as much as 15 pounds; others will not sustain 6 pounds.

It is difficult to state what actually constitutes a short cord. It varies with the amount of stretching it will bear, with the place of attachment to the placenta, with the site of the placenta, and with the tightness of the coils.

The Diagnosis of this condition is not easy. Sometimes there is marked pain at the placental site during contractions, marked recession of the head between pains, delayed labor, and occasionally irregular fœtal heart-action. Brickner states that in the second stage the retraction of the head relieves the compression of the urethra, causing a spurt of urine at the end of a pain.

When the cord encircles the fœtus and the latter is driven down, it rotates partly with the pains to undo the coiling, and so to relieve tension.

The Treatment consists in freeing the coils, where it is possible, or in dividing the cord and delivering by forceps. If the cord cannot be ligated, two artery forceps may be attached to it, and it may be divided between them. Where these procedures cannot be carried out forceps should be applied if the head presents, and labor should be hastened if it be a breech case.

Unduly Ossified Skull. The skull bones may be prematurely or abnormally ossified, the sutures and fontanelles being partly or wholly closed. The head fails to undergo moulding in labor and delay results; it may be arrested in the brim or pelvic cavity.

The application of forceps, symphysiotomy, or embryulcia may be necessary to delivery.

Large Size of the Fœtus. In the case of a large child—*e. g.*, eleven pounds or more, there may be delayed labor. There are records of children delivered weighing more than twenty pounds. The causes are not definitely known. It is thought that multiparity, large size or advanced age of one or both parents, and unusual extension of the period of pregnancy are related to its occurrence.

The mechanism of labor by which the head attempts to pass through the pelvis is like that which takes place in a justo-minor pelvis, viz., by extreme flexion. The head becomes greatly moulded. Cephalhæmatoma may be produced.

Treatment. In cases which are not very marked, extraction may be carried out with forceps. In very marked cases, however, this is useless, and may lead to bad lacerations. Pinard's rule is a good one, viz., never to overcome bony resistance by forceps-traction. Embryulcia or symphysiotomy is then necessary.

Adhesion of Membranes. In some cases the membranes do not separate from the lower uterine segment in the beginning of labor, thus retarding the progress of the first stage.

When the condition is recognized, an effort should be made to detach them with a finger. To accomplish this it may be necessary to dilate the cervix somewhat. If the procedure be satisfactorily performed, labor may be allowed to continue. If the cervix be considerably dilated, and the membranes cannot be separated, they should be ruptured. If accidental rupture take place while the cervix is only slightly dilated, a Champetier de Ribes bag should be introduced and labor allowed to proceed.

Pouching of the Bag of Membranes. In the first stage the membranes may pouch downward into the vagina, the amniotic fluid being forced into it by the pains. The dilating function of the bag is impaired and labor prolonged. The complication arises usually when the presenting part does not fit well into the lower uterine segment as the result of some condition of the fœtus, bony canal, or soft parts—*e. g.*, transverse presentation, flat pelvis. The pouch may rupture prematurely or may sometimes be preserved during the second stage. The cord may prolapse into it.

When the condition is discovered, careful examination should be made to determine the existence of some important cause. The latter may thereupon demand the chief attention. After well-marked pouching has occurred the bag is useless as a dilator. Artificial dilation of the cervix may be necessary if labor be long delayed or the patient be worn out.

Toughness of Membranes. The membranes may sometimes be tough and fail to rupture when the cervix is well dilated. Labor may thus be delayed. Rupture may not take place at all or only when the head is low in the pelvis. Whenever this condition is discovered after complete dilation of the cervix, the membranes should be artificially ruptured with an instrument or with the fingers.

Death of the Fœtus.

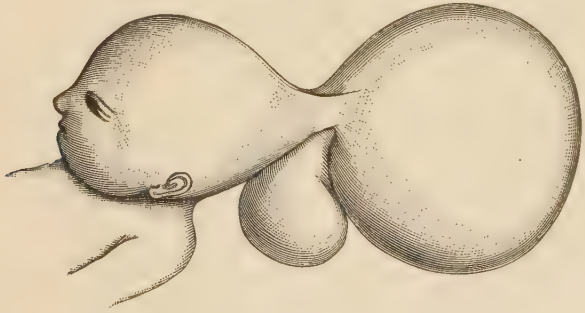
When a fœtus dies in utero decomposition changes may cause distention of its tissues with gas, and this condition, known as *emphysema*, may delay labor. In such a case it may be necessary to puncture the abdomen, or any part distended, to allow the gas to escape. Rigor mortis may sometimes take place in the body and interfere with its quick passage.

It is to be remembered that absorption from a decomposing fœtus may hurt the mother.

Enlargement of Head or Body by Disease.

Hydrocephalus. This condition causes delay and trouble in labor, varying according to the nature of the hydrocephalus. The head enlarges by an accumulation of serum in the ventricles of the brain, especially in the lateral ones. Sometimes a collection in the membranes covering the

Fig. 353.



Hydromeningocele. (After Herrgott.)

brain, especially the subarachnoid space, may cause enlargement, and a projection may take place through the skull, known as *hydromeningocele*. (Fig. 353.)

FIG. 354.

Encephalocele. (After VROLIK.)

FIG. 355.

Puncture of spinal canal in a case of hydrocephalus obstructing labor. (After HERRGOTT.)

In the former of these conditions, where the disease is not much developed, the bones, fontanelles, and sutures may appear normal, with the

exception that the bones are thinned, the brain being well formed, but large. In more marked cases the ventricles are enlarged, the brain-convolutions somewhat obliterated, and the bones of the cranium separated from one another and thinned. The forehead is increased in size relative to the face, the frontal bones bulge, and the superciliary ridges are prominent. In the most extreme degree the head is very large, being mainly membranous, the brain being represented only by a thin

FIG. 356.

Exomphalos. (After A. R. SIMPSON.)

sac, and by traces of cerebral tissue at the base. Sometimes hydroencephalocele is formed during the course of enlargement, owing to the extension outward, between a deficiency of bone, of the skull contents.

Spina bifida, or some other malformation, may also occur. Sometimes the large sac ruptures, the membranes collapsing and becoming attached to the brain structures at the base of the skull (anencephalus or hemicephalus). Hydramnios may be present. Breech presentation is frequent.

DIAGNOSIS. On abdominal palpation, where the head is distinctly enlarged, it may be easily felt. When the breech presents the head is found at the fundus uteri. The abdomen may be abnormally distended. *Per vaginam,* during labor, the wide fontanelles and sutures may be felt. Thin parchment-like bones may be distinguished, or a membranous condition of the vertex may be felt—a fluctuating sac becoming tense during the pains. Or islands of bone may be distinguished in the mem-

brane. Sometimes a hydrocephalus may be present, but the bones may be firm and the sutures more or less ossified; in this case it may be more difficult to establish a clear diagnosis unless the head is considerably enlarged.

Prognosis. This varies according to the degree and extent of the disease and the nature of the treatment which is employed. The longer the delay the greater the risk. Death of the mother may occur from exhaustion or from rupture of the uterus. Rupture generally occurs in the lower uterine segment, which becomes greatly stretched and thinned; but it may take place higher up. Vesico-vaginal fistula may result from long-continued pressure. The child very often dies.

Fig. 357.

Sacral tumor. (Keller: Mütter Museum, College of Physicians.)

Relation to Labor. Sometimes there may be little delay even when the head is large. This is due to softness and compressibility of the skull, especially when somewhat macerated or when it is mainly membranous, and to rupture of the membranous cranial sac. The latter occurrence is most apt to take place when the breech presents. Delay may occur at the brim or in the cavity.

Treatment. Little value need be attached to the life of the child. If it does not die in utero, it usually dies soon after birth.

When the head presents it should be perforated and drained with a trocar. When the head collapses, delivery may be effected either by version or by embryulcia if the former method be inadvisable.

If the fœtus presents by the breech, either the head may be perforated behind the ear, as it lies at the brim, or Tarnier's method may be adopted, viz., to open the spinal canal and draw off the fluid by an elastic catheter passed through the spinal canal into the head. (Fig. 355.)

In the cases where the skull is enlarged, the bones still firm, and the sutures possibly ossified, it is usually necessary to perform embryulcia.

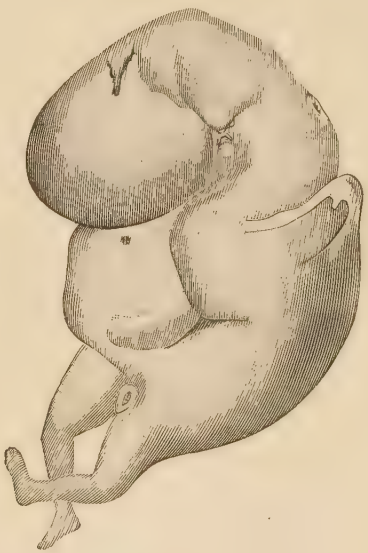
Hydrothorax may cause trouble; it is generally associated with ascites, anasarca, or other conditions. It may obstruct labor, usually when the head has passed the brim. It may be necessary to puncture the thorax and extract with a cranioclast, reducing the size of the head, if necessary. Pericardial effusion may sometimes be very great.

Ascites is sometimes met with, and is due to various conditions—*e. g.*, abdominal tumors, syphilis. It may be a cause of obstruction, and in some cases a very marked one. As soon as the condition is diagnosed the size of the swelling should be reduced. This may be carried out by direct puncture of the abdomen. But it may be necessary to reach this part through the thorax. If a large tumor exists, it may be necessary to break it up or remove it.

FIG. 358.

Congenital elephantiasis. (After STEINWIRKER.)

FIG. 359.



Œdema of fœtus. (After BETSCHLER.)

Distension of the Ureters and **Hydronephrosis** are rare.

Dilation of the Bladder. This condition is occasionally found. The urethra may or may not be imperforate. The fœtus is rarely born alive or, if living, soon afterward dies. It may sometimes be associated with ascites.

Dilation of the Uterus, the cervix being closed, is very rarely found.

General Œdema of the body is occasionally met with. (Fig. 359.)

Abdominal Intrafœtation has been reported. In this condition the abdomen contains another fœtus, or part of one, which causes enlargement.

Umbilical Hernia, or hernia through some other part, may lead to obstruction in labor.

Exomphalos may cause delay. (Fig. 356.)

Tumors of the liver, kidney, spleen, pancreas, and other viscera, sometimes occur.

Hydrorrhacis. This usually occurs with spina bifida. It is a collection of fluid in a sac composed of the spinal membranes and skin, and is usually in the coccygeal or sciatic region. The swelling varies; it may be very large.

Tumors of various kinds, simple or malignant, may obstruct delivery—*e. g.*, cystic, vascular, fatty, cartilaginous, bony, sarcomatous, carcinomatous, teratomatous. Most frequently they are found in the region of the sacrum and coccyx—*e. g.*, cystic hygroma. The neck is also an occasional seat of a growth. They are, however, found in every region of the body. (Fig. 357.)

Treatment. The general treatment for these conditions is as follows: When the swelling is only slight, delivery may be effected by forceps or version; if the breech present, by traction and pressure from above.

If too large for delivery, puncture of the swelling or reduction by embryulcia and evisceration are necessary. Thus, if, in a head presentation, the abdominal swelling cannot be reached without opening the thorax, the latter procedure should be carried out. It may even be necessary to reduce the head in size or to amputate it in order to get room. Sometimes the swelling bursts of itself.

The following very rare conditions sometimes cause obstruction, viz., anchylosis of joints, adhesions of limbs to the body, to placenta, or uterus.

Plural Births.

Twins. Relation to Labor. In a large percentage of cases twin labors are easy and uncomplicated. After the birth of the first child the second follows, there being an interval between, usually of less than an hour in extent, though it may be longer. Several cases have been reported in which the second child was born a day or two after the birth of the first. Kalnikoff has described one in which there was an interval of three days, both twins surviving; both placentæ were removed at the second delivery. The placentæ are generally delivered after the second child. Sometimes the first child may be followed by its own placenta. Sometimes the second placenta precedes the second child. Where the placenta is a large single one, it follows the birth of both fœtuses, though sometimes a portion may be torn off and expelled with the first child.

The following percentages are given by Spiegelberg to show the relative frequency of the presentations met with:

Both heads presenting, 49 per cent.
Head and breech, 31.70 per cent.
Both breech presentations, 8.60 per cent.
Head and transverse, 6.18.
Breech and transverse, 4.14 per cent.
Both transverse, 0.35 per cent.

The pains may be weak in twin cases, owing to the overstretching of the uterus, and there may be trouble in the third stage from this reason also. Hydramnios may be present. In some cases this may be found only in one amniotic cavity, oligohydramnios being the condition in the other.

Prognosis. The mortality of the children is considerably greater than in single births. This is due to various causes. The labors are often premature and the fœtuses, consequently, in an undeveloped state, one being usually weaker and smaller than the other. Malpresentations and malpositions are frequent, necessitating artificial delivery. The maternal risk is also considerable. This is due to the delay which is often present as a result of weak pains; albuminuria is often found; eclampsia is more frequent than in single births; there may be trouble in the third stage from the large placenta, and from inertia uteri; post-partum hemorrhage may occur; there is a greater risk of septic absorption in the puerperium. If there is complete obstruction to the passage of the twins, the patient may die of exhaustion or of rupture of the uterus. Then there are risks attendant upon operative interference.

Management of Labor. After the birth of the first child the cord must be tied in two places and divided, lest there be communication between the placental circulations and the second child should bleed to death. The uterus should then be gently kneaded through the abdominal wall to favor its retraction. There is a difference of opinion as to how long a time should elapse between the birth of the first and that of the second child. Our opinion is that it should not be prolonged, for, though the mother may gain strength, retraction and contraction of the cervix may occur. If the second child is transverse it should be turned. This may often be done by external manipulations. While the second child is being born a hand should be kept on the abdomen following the uterus. After this child is born the hand should hold the fundus uteri until the placenta is delivered. If there should be partial separation of the placenta and hemorrhage, the uterus should be emptied artificially. If there is inertia of the uterus, special care must be taken, according to the methods described on page 415.

When the second child is discovered only after the birth of the first, the mother should not be informed, lest the shock should inhibit uterine action.

If, after the birth of the first child, an hour elapses without the delivery of the second, the second bag of membranes, if there be one, should be ruptured, and the child delivered by version or forceps.

In some cases it may be necessary to deliver the second child much earlier—*e.g.*, if both placentæ should be born before it, or if there should be much hemorrhage following the birth of the first child.

Complex Cases. 1. Sometimes labor may be delayed by the presence in the dilating cervix of two bags of membranes. When dilation is complete the bag of the leading child should be ruptured.

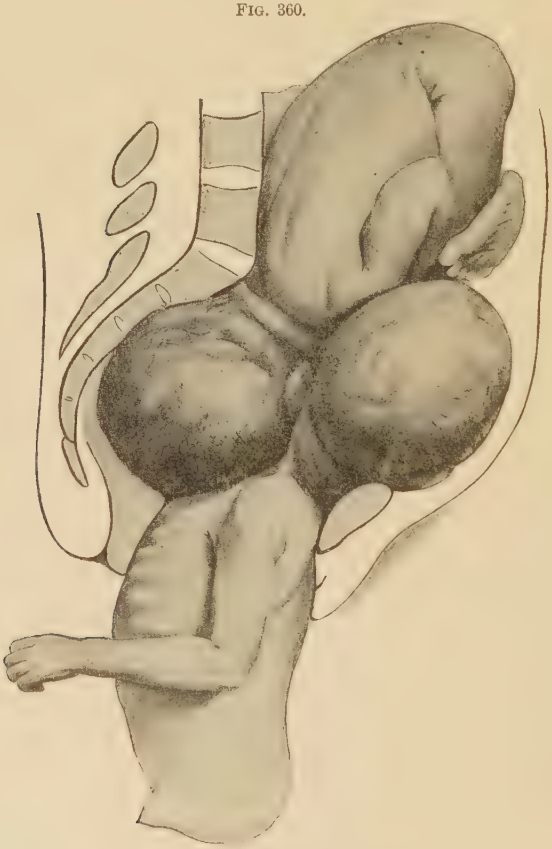
2. Where both presenting parts tend to enter the brim together, one should be pushed up to allow the other to engage. Where the head of one and the breech of the other are so placed, the head should be allowed to engage.

3. **Interlocking Twins.** In some cases the twins may become locked. This may happen in two ways :

(*a*) Where both heads present, the second may enter the pelvis after the first and jam against the neck or thorax. The heads must, of course, be small to permit this complication.

(*b*) In some cases where one child presents by the breech and the other by the head, the former may be delivered as far as the neck, but no farther, because the head of the second child has locked with that of the first; this may take place by overlapping of the chins, or of the occipital regions, or the face of one may be pressed against the back of the neck of the other. This locking occurs in the pelvis. (Fig. 360.)

FIG. 360.



Interlocking twins. (BUMM.)

TREATMENT. (*a*) The most advanced head should be delivered with forceps, and then the other should be delivered.

Sometimes embryulcia of one is necessary. This should be performed on the first child, because the second is more likely to be alive, there being less risk of compression of its cord.

(*b*) Sometimes the head of the second child may be pushed up. If this is impossible, and nature cannot soon bring about delivery, the head of the second child may be delivered by forceps. If this is

impossible, or if there is great difficulty in applying the blades, embryulcia should be performed on the head of the child which is dead. In almost every case this is the breech-first child. After the extraction of the mutilated child the other may be delivered.

FIG. 361.

Prosopothoracopagus.

4. **Interlacing and Knotting of the Umbilical Cord.** This may occur where there is only one amniotic sac. The cords may be twisted around one another in various ways, or even knotted. If this happens early in pregnancy there is great probability that death of one or both twins will occur and premature labor be induced. It may, however, be found at full time. As labor proceeds one cord may drag on the other and imperil circulation.

TREATMENT. If after delivery of the first child the condition is diagnosed, the second child should be delivered at once by version or turning.

Triplets. The greater the number of fœtuses the greater the tendency to prematurity of delivery. Consequently, the labors may sometimes be comparatively easy. Sometimes, however, they are considerably prolonged. The first stage is usually longer than normal.

Albuminuria is more frequent; also inertia uteri and hemorrhage during or after labor. In 458 triplet cases collected by Charbonnier there were

254 head presentations, 117 breech, and 57 transverse. According to this author there is a very small percentage of cases in which malpresentation and malpositions have caused serious trouble. The third stage

FIG. 362.

Derodyme or derodidyme. (After AHLFELD.)

must be very carefully attended to. Generally the three fœtuses precede the placentæ. Sometimes, however, each is followed by its own. Sometimes there are two fœtuses, then one or two placentæ, followed by the third fœtus and its placenta. Sometimes one fœtus and its placenta are first, then the other two and their placentæ.

MONSTROSITIES.

Anencephalus or Hemicephalus. In this form the neck is short and the shoulders may be very broad.

Delay in labor is caused by the bad action of the deformed head as a dilator, by the breadth of the shoulders, or by the entrance into the brim of the small head along with other parts of the fœtus. Turning should be employed if the case be diagnosed early enough.

Acardiacus is another rare monstrosity which may interfere with labor.

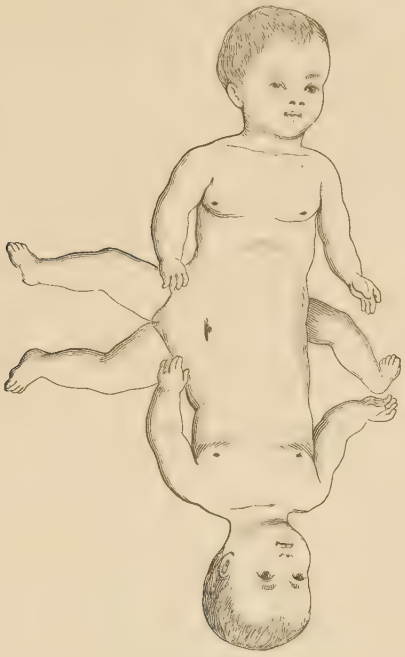
Double Monsters. These may be considered in three main groups:

1. Those in which there is double formation in the upper part of the body—*e. g.*, a two-headed monster.

2. Those in which there is double formation of the lower part.

3. Those in which there are two heads and two bodies:
   (*a*) Those in which the backs are united.
   (*b*) Those in which the bellies are united. (Figs. 361, 362, 363.)

FIG. 363.



Ischiopage.

DIAGNOSIS. This may be very difficult during labor. It can be best arrived at when the hand is passed into the uterus. Double monsters are apt to be mistaken for twins.

RELATION TO LABOR. In many cases these monsters are delivered naturally, probably because the fœtus is usually small.

Lroff has recommended the following treatment: When both heads present, and are movable, one should be pushed up, in order to allow the other to engage. Turning may sometimes be tried in order to deliver the legs first. Forceps may be used to aid the advancing head. Sometimes embryotomy is necessary.

CHAPTER XXI.

ANOMALIES ARISING FROM ACCIDENTS OR DISEASE.

Prolapsus Funis.

In this accident a loop of the umbilical cord slips down alongside the presenting part or in advance of it. As the labor progresses the displaced portion of the cord is exposed to strangulation by pressure between the presenting part and the walls of the birth-canal. Unrelieved, the complication, as a rule, results in the death of the fœtus within a few moments by interruption of the fœto-placental circulation. In exceptional instances the cord may escape injurious pressure and the child be born alive. This is possible when the pelvis is relatively roomy and the expulsion of the fœtus is accomplished in one or two pains. Prolapse of the cord may take place before labor begins, but in the majority of cases it does not occur until the cervix is well dilated. Ordinarily the two halves of the prolapsed cord lie in apposition, but occasionally the presenting portion of the child may intervene. Thus in vertex presentation the loop may extend upon opposite sides of the head, and in shoulder or footling presentation may include an arm or a leg. The prolapse occurs most frequently at one side of the promontory, rarely along the lateral wall of the pelvis, and still more rarely near the median line in front.

When the prolapse is within the bag of waters, it is sometimes spoken of as presentation of the funis.

Frequency. The frequency of prolapsus funis as generally estimated is about 1 in 250 labors. According to Winckel, it happens once in from 65 to 500 cases. In a collective investigation by Churchill, prolapse of the cord was reported 852 times in 91,000 births, an average of 1 in 107 cases. The complication is met most frequently when an extremity presents, next in order of frequency in breech, and last in vertex presentations.

Etiology. The essential cause of prolapse of the cord is failure of the presenting part of the fœtus to fill completely and continuously the lower uterine segment. Conditions, then, which may give rise to this lack of close approximation are predisposing causes of prolapsus funis. They are: narrow pelvis, which may act not only by hindering the adaptation of the head to the passages, but also by favoring the occurrence of malpresentation; uterine myomata; diminished size and consequent mobility of the fœtus, favoring malpresentation and malposition; abnormal presentation, especially shoulder and footling presentation; excess of liquor amnii, causing preternatural mobility of the fœtus; multiparity, owing to relaxation of the abdominal walls and to uterine obliquity, especially to pendulous abdomen. Low implantation of the placenta, marginal insertion or excessive length of cord also favors prolapse.

An important exciting cause is premature rupture of the membranes

and the sudden escape of a large amount of amniotic fluid, particularly if the woman is in a standing or sitting posture when the rupture occurs; the escaping fluid may sweep out a loop of the cord in front of the presenting part of the child. Violent movements on the part of the mother favoring recession of the fœtus from the lower uterine segment and promoting gravitation of the cord may be included among the possible factors in bringing about the displacement. Maladroit attempts at version are sometimes responsible for the prolapse.

Diagnosis. The examination should be made between the pains. The condition can scarcely be recognized before the os has dilated if the membranes are still intact. Rarely it may be possible, if the lower uterine segment is thin, to detect, with the examining finger at the utero-vaginal junction, the pulsation of the cord. It is distinguished from the maternal pulse by the count.

If the os is sufficiently dilated to admit the finger the cord may be felt when it lies well down in the membranes. Yet it may escape detection, owing to the facility with which it recedes from the examining finger.

When the fœtus is dead pulsation, of course, is absent. The absence of pulsation, however, can be taken as evidence of fœtal death only when persistent for ten or fifteen minutes. The funic pulse may be interrupted temporarily by compression of the cord between the pelvic brim and the presenting part. The fœtal heart should be listened for.

Fingers and toes are distinguished from the cord by their anatomical characters. Fœtal parts, too, will sometimes be drawn up when touched.

The prolapsed cord should not be mistaken for intestine. The latter is recognized by the mesentery and by the absence of pulsation. It is larger than the cord and not so firm in consistence.

After the membranes have ruptured, and the cord protrudes into the vagina or through the vulva, the diagnosis presents no difficulty. The presence or absence of pulsation should always be noted, to determine whether the child is living or not, since this question will obviously have an important bearing on the treatment. Should the displaced loop be caught between the presenting part and the sides of the pelvis, but fall no farther, the condition may escape detection and the child be asphyxiated before the cause is discovered. Winckel says that when the fœtal heart-sounds grow continually feebler and no cause is apparent, prolapse of the funis should be suspected, and the physician should act accordingly.

Prognosis. In general this complication of labor has, of itself alone, little influence upon the mother. Yet the treatment necessitated in the interest of the child frequently subjects the woman to the risks of shock, hemorrhage, and sepsis usually attendant upon forced delivery.

For the child the prognosis is exceedingly grave. Half the children die of asphyxia. The prognosis, however, must necessarily vary with the conditions of the case, such as the position and presentation of the fœtus, the degree of displacement, the part of the pelvis at which it occurs, the size of the cord, and the duration of the prolapse. Prolapse of the cord in vertex and in breech is more surely fatal to the fœtus than in other presentations, since the presenting part more completely fills the pelvis and the cord is more surely strangulated. The risk to the fœtus is comparatively small while the membranes are intact. The possibility of

escaping injurious pressure is obviously greater when the cord lies in that part of the pelvis in which there is most room. The size of the cord has some influence, since the thicker the cord the greater the amount of Wharton's jelly and the consequent protection of the vessels. With primiparæ, in whom the passages are more unyielding and the labor more prolonged, the fœtal mortality is greater than with women who have previously borne children.

Treatment. Before attempting reposition the obstetrician must have assured himself of the capacity of the pelvis, of the presentation and position of the fœtus, and especially if the child is living and viable. When the child is surely dead or non-viable, obviously the reposition of the cord is not called for.

Before Rupture of Membranes. When the child presents by the breech or shoulders, reposition of the cord is not always required till dilation is complete; the cord in these presentations is little exposed to strangulation during the first stage of labor. When the child is living and the membranes are unruptured, the latter should, if possible, be preserved. Sometimes for this purpose a water-bag may be placed in the cervix. It should be a general rule before rupturing the membranes in any case first to examine for possible prolapse of the cord. For reduction of the displacement while the bag of waters is still intact postural measures should be tried. The woman is required to lie on the side opposite that on which the cord has come down. Gravity thus favors the return of the prolapsed loop. The reposition may be assisted, if need be, by gently pushing up the cord between the pains, with care to avoid breaking the membranes.

Should this fail, the woman may be placed in the knee-chest position. In this posture the inverted axis of the uterus is nearly vertical, and gravity acts at the greatest advantage. The Trendelenburg posture may serve as a convenient substitute for the latter position. While not so effectual as the knee-chest, it is more so than the lateral posture; the inclination should be about 45 degrees.

A fairly good Trendelenburg posture may be had by raising the foot of the bed or cot, slipping down in the bed being prevented by the help of assistants; or a chair placed prone upon the bed may be utilized, the back being covered with a folded comfortable.

The fœtal heart is to be listened for at short intervals. The cord once reposited, to prevent recurrence of the prolapse the presenting part should be crowded into the excavation and firmly held there till engaged.

After Rupture of the Membranes. If the fœtal pulse can be felt, the cord should be replaced, if possible. If pulsation has ceased and the fœtal heart is still beating, the presenting pole of the fœtus should be pushed up and the cord reposited after pulsation returns. Two methods are available—the manual and the instrumental. Either is to be undertaken with the aid of posture and generally of anæsthesia. The knee-chest, the Trendelenburg, or even the lateral position, with the hips strongly elevated, may be chosen. The first is the most effectual, but is not always practicable, under anæsthesia, without the aid of skilled assistants.

Manual Method. It must be remembered that much handling of the cord enfeebles the circulation and endangers the life of the child.

The cord should be gently drawn to the front of the pelvis, where the reposition can most easily be effected. It is seldom that the prolapsed loops can be caught up in the hand and returned into the cavity of the uterus or even pushed up inch by inch; as fast as one part is reposited another comes down. Yet success is sometimes possible by either of these plans. A method which has rarely failed in the writer's hands is this: The prolapsed loop is *loosely* twisted into a rope with great care to avoid interference with the circulation. It can then readily be replaced within the uterus. For retention, the woman may be kept in the latero-prone position, or the presenting pole be held in the brim till engaged. Occasional examinations are made per vaginam to make sure that the cord has not again slipped down. The fœtal pulse-rate is listened for at frequent intervals.

Instrumental Method. A suitable instrument for repositing the prolapsed cord may be improvised with a large English catheter and a few feet of tape. A loop of the tape is made to encircle the cord loosely, and its free ends are attached to the tip of the catheter. The repositor, with a stylet inserted, is pushed into the uterus, carrying the cord with it, well up to the fundus. The stylet is withdrawn and the catheter left to be expelled with the child. If preferred, the tape may be secured to the catheter by a bow-knot, which can be untied by pulling on the free end of the tape, the cord thus being set free. The instrument may then be withdrawn. Recurrence of the prolapse is prevented by pressure over the fundus, holding the presenting pole in the brim till firmly engaged.

Version or Forceps. Attempts at reposition failing, if the child is still living, immediate resort should be had to version or forceps. It is sometimes possible to save the child by rapid delivery without replacing the funis. Prompt extraction by the feet without reposition, when possible, is especially suited to shoulder and to primary breech presentations. If needed to facilitate delivery the cervix may be dilated manually or be incised. The cord should first be disposed in front of that sacro-iliac joint opposite which there is most room.

INVERSION OF THE UTERUS.

Inversion of the uterus may be complete or partial. In complete inversion the organ is turned inside out and upside down. In partial inversion it presents a cup-shaped depression of greater or less depth at the fundus.

Inversion of the uterus seldom takes place except at term, yet we have records of cases complicating miscarriage at six months, and Woodson reports a complete inversion following miscarriage at four months.

Frequency. Fortunately this accident is exceedingly rare. Winckel had never seen a case of complete inversion of the uterus in 20,000 cases of labor, nor had Braun in 250,000. In 192,000 labors at the Rotunda Hospital in Dublin, covering a period of nearly a century, one case was observed. Judging from the number of cases that have fallen under my observation, the accident is more frequent in private than in hospital practice. Kehrer says it is believed to occur once in 2000 labors in general practice.

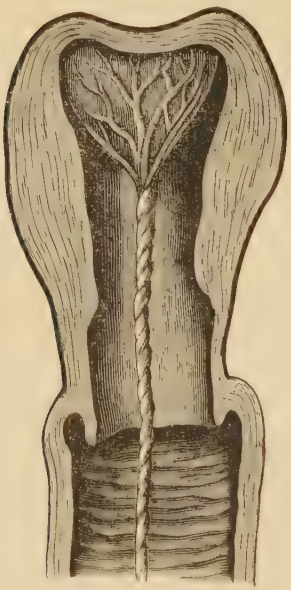
Varieties. The inversion may be acute or chronic. The latter variety concerns the gynecologist rather than the obstetrician, and will not be discussed in this connection. Three degrees of acute inversion are recognized:

1. A cup-shaped depression of the fundus, the latter approaching but not engaging in the os uteri. (Fig. 365.)

2. Partial inversion, the fundus protruding from the os. This is a true intussusception. (Fig. 366.)

3. Complete inversion (Fig. 367). In the latter variety, the uterus being turned inside out, the body of the organ may project from the vulva, appearing between the patient's thighs. In the funnel-shaped

FIG. 364.



Beginning inversion of uterus, placenta attached. (Modified from RIBEMONT-DESSAIGNES and LEPAGE.)

FIG. 365.

Cup-shaped depression of fundus. (Modified from RIBEMONT-DESSAIGNES and LEPAGE.)

depression formed by the inverted uterus may be found, in addition to the appendages, small intestine and a portion of the omentum.

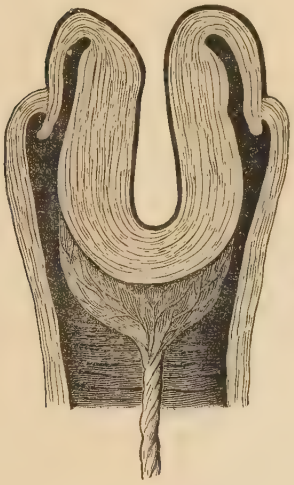
Etiology. The one factor of paramount importance, and in the absence of which inversion is practically impossible, is atony or paresis of the uterine muscle. As Crampton says: "Inversion of the uterus is preceded by paresis of some portion of the uterine muscle, not necessarily at the placental site, the main causes being too frequent child-bearing, tedious labors, precipitate labors, repeated miscarriages, and traumatism."

The accident is most likely to occur either at the moment the child is born or during the third stage of labor. Inversion of the uterus may originate in any of the following ways:

1. The inversion may be spontaneous. When the placental attachment is at the fundus a temporary atony of the uterine muscle at

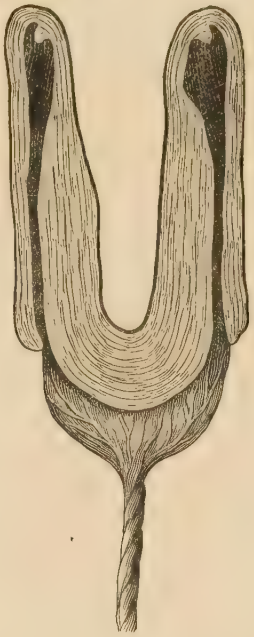
this point may cause a dipping down of the fundus, and the beginning inversion may be increased by the weight of the placenta, if still attached, and of the abdominal viscera pressing upon the fundus from above. (Fig. 364.) The inverted portion now acts as a foreign body, and being firmly grasped by the non-paralyzed segment of the uterus, it is driven further down at each contraction of the organ. A similar phenomenon is observed in intussusception of the bowels. Inversion arising in this manner is most likely to be incomplete. Sudden or unexpected delivery in the standing posture may be followed by inversion.

FIG. 366.



Partial inversion of uterus. (Modified from RIBEMONT-DESSAIGNES and LEPAGE.)

FIG. 367.



Complete inversion of uterus. (Modified from RIBEMONT-DESSAIGNES and LEPAGE.)

2. The accident may be caused by unskilful pressure of the obstetrician's hand on the fundus. Instances have been reported in which inversion of the uterus was produced by attempts at expressing the placenta directly after the completion of the second stage of labor. If, before sufficient time has elapsed for contraction to occur, forcible pressure be made on the fundus, inversion may result.

3. A possible cause is believed to be traction upon the cord in the endeavor to remove the placenta shortly after the child is born. The relaxation of the uterus usually present at this time favors the inversion. For traction on the cord to produce inversion there must be some attendant atony. In the absence of inertia the cord would break under less strain than necessary to invert the uterus. In exceptional instances of short cord the fundus may be dragged down by the tension put upon the cord as the child is expelled.

Symptoms. The usual symptoms of inversion of the uterus are pain, hemorrhage, vesical and rectal tenesmus, and profound shock. The intensity of the symptoms, however, varies greatly in different cases. Ordinarily the pain is severe. It comes on abruptly, and is referred to the lower abdomen and the pelvis. The abdomen is painful to the touch. The hemorrhage may or may not be profuse, depending upon the degree of uterine relaxation. In exceptional cases it is insignificant; generally it is excessive. In the latter event the symptoms of acute anæmia are present.

The vesical and rectal symptoms are sometimes wholly absent. Occasionally there is retention of urine. Reeve reports two cases of complete inversion in which there was nothing in the patient's appearance or history to excite suspicion of the accident. Jewett has published a similar case.

Diagnosis. As a rule, the acuteness and severity of the symptoms are such that they can scarcely fail to arrest the physician's attention should he be present when the inversion occurs. The diagnosis, however, must rest mainly on the physical signs. These are essentially the absence of the usual abdominal tumor, the presence of an intravaginal tumor, and the character of the tumor. It is indispensable to a satisfactory physical examination that the bladder and the rectum be empty. If the examiner is expert, the absence of the uterus in the abdomen may be determined beyond all possibility of doubt by the combined abdominal and vaginal, followed, if necessary, by the abdomino-rectal examination. The presence of the vaginal tumor is obvious to the touch, sometimes to the eye. It must, however, be differentiated from a uterine polypus. The distinguishing points are the following: The inverted uterus presents a more funnel-shaped depression at the cervix, which generally may be made out with one hand over the abdomen, the other making counter-pressure over the tumor within the vagina. If the inversion has existed for several days the abdomen may be too tense and too tender for satisfactory palpation; but this difficulty may be overcome by anæsthesia. In uterine inversion the implantation of the pedicle is circular, while in a polypus it is lateral. In the latter condition a uterine sound may be passed by the side of the pedicle into the uterine cavity, while in the former the sound will be arrested at the root of the pedicle. Sometimes it is possible by inspection with the aid of the speculum to detect upon the surface of the tumor the openings of the Fallopian tubes. The special contractility of the uterus may aid in differentiating. The possible presence of the placenta still adherent to the uterus must be borne in mind. Distinction from a polypus, however, is sometimes difficult.

Prognosis. Inversion of the uterus is among the most formidable complications of childbirth. Death may occur within a few hours from hemorrhage and shock, or later from septicæmia. Rarely a chronic inversion may exist for months or years. In exceptional instances spontaneous reposition has taken place, and recovery has been known to follow the separation of the organ by sloughing. The total mortality may fairly be stated at from one-quarter to one-third.

Treatment. PROPHYLAXIS. Puerperal inversion of the uterus is generally, if not always, a preventable accident. It is scarcely possible under proper management of the third stage of labor. The prophylaxis con-

sists in the avoidance of traction upon the cord while the uterus is relaxed and of manipulation which may indent the fundus, and, finally, in properly directed efforts to bring about a prompt and persistent retraction of the uterus. If the uterus is intelligently watched, with the hand on the abdomen over the anterior surface of the fundus, from the moment the child is expelled till retraction is complete, the slightest depression at the fundus may immediately be detected and reduced. Usually failure to contract normally may be corrected by friction or by compression applied over the anterior uterine wall with one or both hands.

Reposition. Three methods of taxis are available for the reduction of a recent inversion of the uterus:

The first consists in grasping the fundus of the uterus in the hollow of the hand and making gentle but firm pressure upward, counter-pressure being maintained with the other hand upon the abdomen. Reposition is possible in this manner only while the uterus is still relaxed, directly after the accident.

In the second method the hand is carried into the vagina with its back toward the sacrum, and with the fingers a part of the lower uterine segment is pushed upward through the constricting ring. With the fingers of the other hand applied over the abdomen the cervical ring is dilated. As the ring yields, the lower segment and, finally, the entire body of the uterus is pushed upward through the cervical girdle. Care should be taken to direct the pressure toward one side and well forward in order to avoid the promontory of the sacrum.

The third method consists in making pressure at the middle of the fundus or near the orifice of either oviduct with the coned fingers.

As a rule, the reduction of the inversion by whatever method is to be undertaken only with the aid of an anæsthetic.

Reposition being complete, the hand is kept within the uterus for several minutes till a contraction occurs. To excite uterine contraction and stop the bleeding, ergot is administered subcutaneously. Putting the child to the breast may help, or an intra-uterine douche of sterilized water, at a temperature of 120° F., may be given. Rarely it may be found necessary to tampon the uterus with plain or washed-out iodoform gauze.

Should the placenta be attached to the inverted uterus, it may be separated before repositing, especially if partially detached. In marked relaxation of the uterus the placenta, if still adherent, should not be detached lest troublesome hemorrhage result. When inversion has existed for several days or more, attempts at reduction may still be made, but with much less chance of success than at the close of labor.

In difficult cases advantage may be taken of the knee-chest or the Trendelenburg position. It is scarcely necessary to say that all manipulation or instrumentation within the vagina must be conducted under a strict asepsis. Owing to the risk of infection in prolonged manipulation extreme measures must be avoided during the puerperium, and attempts at reposition are best postponed for three or four weeks should they not prove successful within a few hours.

If the uterus is infected early amputation generally is advisable, but hysterectomy, together with the treatment of chronic inversion, belongs more properly to the province of the gynecologist.

RUPTURE OF THE UTERUS.

Rupture of the uterus may occur during gestation, labor, or the puerperal period.

In pregnancy, spontaneous rupture is extremely rare and begins most frequently in or near the fundal region. The cause is obscure, but probably is to be sought in some pathologic condition of the uterine musculature, such as atrophy, defective development, fatty degeneration, the scar of Cæsarean section, or of myomectomy. Interstitial tubal pregnancy and pregnancy in one horn of a uterus unicornis usually terminate in rupture before term. When due to external violence the injury may involve any portion, more especially the anterior wall.

In the puerperium the accident is rare, and is generally the result of dissecting metritis, necrosis from injury during labor, or intra-uterine intervention.

The lacerations of childbirth begin in the cervix or the lower uterine segment, and are most frequently spontaneous. More or less extensive tears of the vaginal portion of the cervix are very common, especially in first labors. These are discussed elsewhere.

Rupture of the body of the uterus is among the gravest accidents of obstetric practice for both mother and child. It is with rupture during labor that we are at present concerned.

Frequency. The frequency of this accident has been variously estimated. It is commonly stated at 1 in 4000. From a study of nearly 1,000,000 labors, Jolly concluded that it occurs once in 3400 cases. The latter authority found that in 573 cases of rupture of the uterus, 376 were spontaneous and 197 were traumatic. The percentage is large in countries where rachitis and osteomalacia are prevalent, pelvic deformity often being the primary cause of uterine rupture.

It cannot be doubted that the accident is much commoner in private practice than in hospitals, from the records of which estimates of frequency are mainly derived.

Pathological Anatomy. While rupture of the uterus in labor may involve any portion of the organ, it begins usually in the inferior segment. This is accounted for by the greater distension and consequent thinning to which this portion of the uterus is subjected, especially in obstructed labors attended with violent uterine contractions. The lower uterine segment, too, is exposed to injury by pressure between the child's head and some part of the pelvis, especially the promontory of the sacrum.

The rupture may be complete or partial. In *complete rupture* the tear involves both the muscularis and the peritoneum, opening into the peritoneal cavity. In *incomplete rupture* the laceration extends through the muscular wall only, the serous covering remaining intact. Judging from clinical observation complete ruptures are by far the more frequent, yet incomplete rupture is more likely to pass unrecognized.

In complete rupture loops of intestine may prolapse into the uterus and even into the vagina. Grangrene of the prolapsed loop of intestine from strangulation may result. Frequently a large quantity of blood is effused into the peritoneal cavity; hemorrhage is often the cause of death. Liquor amnii and meconium may escape into the peritoneum.

PLATE XXXII.

Rupture of Fundus, with Total Escape of Fetus into Abdominal Cavity. Rupture also Near Cervix.

PLATE XXXIII.

Rupture of Uterus Due to Necrosis from Pressure of Promontory.

Transverse Rupture of Uterus, Resulting from Thinning of the Wall by Epithelioma

Infective peritonitis rapidly follows the extrusion of the fœtus and placenta into the peritoneum.

The extent, direction, and shape of the tear are subject to wide variation. The size of the rent varies in different cases, from a small opening scarcely large enough to admit the finger tip to a laceration permitting the escape of the child and placenta into the abdominal cavity. It may involve the entire length of the uterus, may invade the vagina, and, in exceptional instances, the bladder. Jewett has reported 2 cases, in each of which the child escaped into the peritoneal cavity through a rent, most of which was in the posterior vaginal vault. Sometimes the vaginal portion of the neck is torn away in the form of a ring before the advancing head.

Most frequently the rupture is lateral. It occurs oftener on the left side, owing to right uterine obliquity and the consequently greater strain upon the left uterine wall, and by reason of the fact that the head lies more frequently on the left side in shoulder presentation. Transverse tears may involve the entire circumference of the organ.

Rarely the tear is even and clean cut. Usually the edge of the wound presents a jagged and irregular appearance, owing to the contractility of the muscular fibres of the uterus. The tissues around the margin of the wound often are swollen and ecchymosed and may be studded with patches of necrotic tissue.

Most frequently the tear in the serous covering takes place at the insertion of the broad ligament.

The laxity with which the peritoneum is attached to the inferior wall of the uterus makes it possible for rupture beginning in the uterine neck to extend upward for a considerable distance in the muscular layer of the uterus without laceration of its serous covering. In subserous lacerations a large subperitoneal effusion of blood may accumulate at the seat of the rent. Sometimes the placenta may be found in the same situation. Complete rupture may be complicated with one or more incomplete lacerations.

Rarely the peritoneal coat may be ruptured, the muscular coat remaining intact. This form of laceration is possible during either pregnancy or labor when from any cause the elasticity of the peritoneum has been impaired.

Complete rupture is almost surely immediately fatal to the fœtus, yet cases have been reported in which the immature fœtus survived its expulsion into the peritoneal cavity, the fœtal sac remaining intact and the placenta retaining its uterine attachment. (See Henrotin on Ectopic Pregnancy, page 400 of this volume.) The placenta almost invariably is detached and frequently is expelled into the peritoneum.

Etiology. The causes of rupture of the uterus are: I. Predisposing. II. Exciting.

I. Predisposing Causes. In the later weeks of gestation the uterus normally becomes greatly distended and its walls softened and thinned. Excessive distention of the uterus occurs in hydramnios, multiple pregnancy, hydrocephalus, and in conditions which lessen the resistance of the uterine wall. Placenta prævia, late primiparity, and systemic disease are to be counted among the predisposing causes. The vast majority of cases are observed in multiparæ. According to statis-

tics collected by Brand, of 546 cases of rupture, only 64 occurred in primiparæ. It is more frequent in women who have borne several children with short intervals between pregnancies. Since male children ordinarily are larger than female, sex, as suggested by Kehrer, may be a predisposing factor. He found that in 20 cases of rupture, 15 were male children.

Traumatism of various sorts, as blows, falls, kicks, etc., may weaken the wall of the uterus at the site of injury. Chronic inflammatory changes and various degenerations of the muscle-fibre impair the strength of the uterine wall.

The weak point may be in the scar left by a former Cæsarean section. Malignant disease of the uterus exposes to rupture. A large neoplasm in the uterus, as a submucous fibroid, may give rise to obstruction and favor rupture. Malformation of the uterus predisposes. Rarely the uterus is perforated in cystic degeneration of the chorion. The commonest of the predisposing causes of uterine rupture is pelvic deformity.

Other conditions giving rise to disproportion between the fœtus and the birth-canal or otherwise causing obstruction, such as extreme uterine obliquity, malpresentations, and malpositions, may predispose. The accident seldom occurs in other than prolonged and difficult labors. While rupture of the uterus rarely occurs before the membranes have broken, a case is recorded by Hamilton in which at the autopsy the lateral wall of the uterus was the seat of a tear of considerable extent, the membranes still being intact.

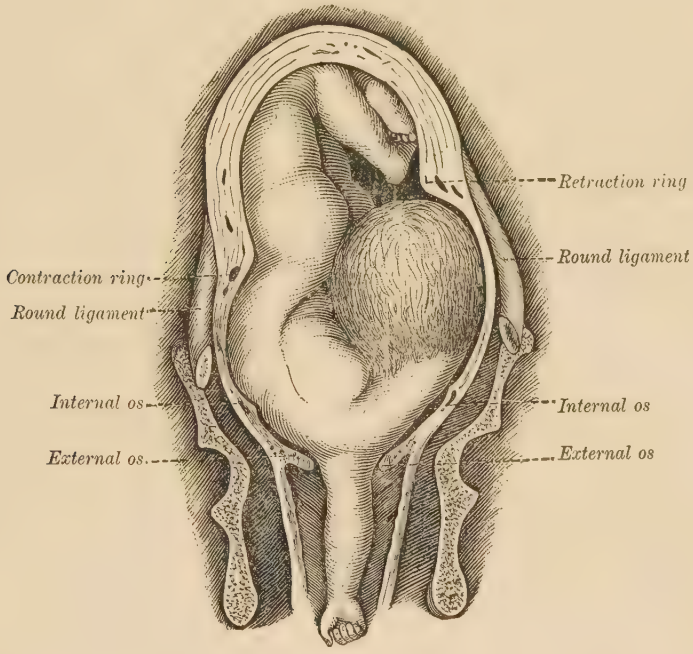
II. Exciting Causes. The exciting causes of rupture of the uterus may be grouped under two heads—traumatism and excessive retraction. Examples of the former class are blows, falls, and kicks. The prominence of the uterine tumor at term increases the risk from external violence to which persons in all walks of life are daily exposed. Rupture occurring from these causes concerns the general surgeon rather than the obstetrician. Of much more frequent occurrence is perforation by the hand or instruments, and rupture from unskilful version, high forceps, manual detachments of firmly adherent placenta, and other obstetric operations. Hess believes that spontaneous rupture of the uterus is infrequent, while the lacerations produced by rough manipulations are comparatively common.

Probably the most important etiological factor of rupture is excessive uterine retraction. Bandl, in 1875, showed that the upper segment only of the uterus is the contractile portion, the lower taking no direct part in the expulsion of the fœtus. As labor progresses the upper portion of the uterus becomes thicker with each contraction, while the lower portion grows thinner and more distended. At the junction of the upper and lower segments there is formed a well-marked line of demarcation, which usually may be felt through the abdominal wall, the "contraction or retraction ring." If during a pain the presenting part meets with obstruction, as in contracted pelvis, or in shoulder presentation, or pelvic tumor, the lower segment of the uterus becomes excessively thinned, until finally, under the influence of an unusually vigorous contraction, rupture occurs. The injudicious exhibition of ergot has, not infrequently, been the cause of rupture. One author reports 3 cases, and another 4, traceable directly to this cause. Jolly collected 33 cases of uterine

rupture in which ergot was given in large doses. In all cases of disproportion, whether referable to the fœtus or to the birth-canal, rupture may be caused in one of two ways: Either as the direct result of excessive and prolonged contractions or by pressure necrosis caused by compression of the uterine wall between the presenting part and the bony pelvis.

Diagnosis. In most instances of uterine rupture the accident is foreshadowed by danger signals that should not escape detection. Persistent cramp-like pains in the lower abdomen are very significant. The same is true of a sense of uterine tension in the intervals between contractions. The pulse-rate is increased. These symptoms demand a careful examination with the aid, if need be, of an anæsthetic. Retraction ring near

FIG 368.



Arm presentation with threatened rupture of thinned lower segment of uterus. (Schroeder.)

the level of the umbilicus or higher is evidence of imminent danger. Obliquity of the retraction ring indicates greater tension and greater risk of rupture on the side on which the ring is higher. The round ligament is more tense on the side of greater uterine tension. The overstretched lower uterine segment is excessively sensitive to the touch. On vaginal examination the fornix may be found tense. (Fig. 368.)

Actual rupture, if complete and attended with extrusion of the child into the peritoneum, is announced by abrupt cessation of labor-pains and by the appearance of a new abdominal tumor separate and distinct from the uterus. Often the former may be identified by palpation of fœtal parts. Fœtal heart sounds and active fœtal movements are absent. The uterine tumor usually contracts down to a globular mass little larger

than a fœtal head. Sometimes the rupture is attended with severe pain and in exceptional cases with an audible sound of tearing. Usually there is a greater or less amount of external hemorrhage.

Upon vaginal examination the presenting part will be found to have receded, or, possibly, some other portion of the child may be encountered, or a loop of intestine be found prolapsed. If one or two fingers or the entire hand are introduced into the uterus, the site of the rupture may easily be detected and the diagnosis confirmed.

Generally the systemic symptoms are marked. During violent expulsive effort or in the course of some obstetrical manipulation the woman is abruptly seized with internal pain wholly unlike a normal labor-pain. As a rule profound collapse quickly follows, yet may be noted only after several hours. The face is pale, exhibits great suffering and apprehension, and becomes covered with a cold, clammy sweat; the respirations are rapid and shallow; nausea, vomiting, and syncope frequently ensue.

When the child has not been wholly expelled from the uterus only a single tumor is found and labor-pains may continue in diminished intensity.

In incomplete rupture the systemic disturbance is far less pronounced, the physical signs even are not always well defined, and diagnosis may be difficult.

Emphysema is sometimes observed in the abdominal wall from the presence of air in the cellular tissue and a hypogastric tumor from blood accumulation may be noted. The emphysema may be due to a gas bacillus.

While characteristic evidence of rupture usually is present, in exceptional cases neither shock, external hemorrhage, cessation of the uterine contractions, recession of the presenting part nor marked local pain is observed, and the true condition can be determined only by intra-uterine exploration or at the autopsy. Very rarely this may be true even in complete rupture. It is important in all cases that the location, character, and extent of injury be carefully made out with the hand in the uterus. In this connection the following statistics from Jolly are of interest: In 580 cases of rupture, contractions ceased in 256; there was external hemorrhage in 148, collapse in 179, recession of the presenting part in 146, and abdominal pain in 133.

Rupture of the uterus must be differentiated from accidental hemorrage and placenta prævia. Hemorrhage from the latter causes begins at an earlier stage of labor, is not attended with recession of the presenting part, nor with the development of a new abdominal tumor. Usually they are easily distinguished from rupture by physical exploration.

Prognosis. In complete rupture of the uterus without radical treatment the prognosis is exceedingly grave. The outcome for the child is almost necessarily fatal, 95 per cent. of all cases resulting in the death of the fœtus. The immediate cause of death is asphyxia. The maternal mortality is not less than 90 to 95 per cent.

The death of the mother may result from primary or secondary hemorrhage or from sepsis. More than one-half of the deaths occur within the first forty-eight hours after the injury. In pre-antiseptic days the outlook was still more gloomy, but with increasing knowledge of abdominal surgery, and the better operative technique of the present day,

the results have much improved. The best results are obtained by the employment of surgical measures, and the operative prognosis is, in a great degree, dependent on the promptness with which resort is had to surgical intervention.

In incomplete rupture, if not complicated with laceration of the bladder or rectum, the consequences are less serious. In a certain proportion of cases good results may be expected by the arrest of hemorrhage, complete evacuation of blood-clots, and proper drainage.

Treatment.—Prophylaxis. In the hands of an alert practitioner rupture of the uterus during labor is almost always preventable. Essential to *prophylaxis* is prompt recognition of conditions which may act as predisposing causes and, if possible, their correction. A hydrocephalic head should be perforated. Violent uterine effort should be controlled by opiates or by chloroform. Excessive strain upon one side of the uterus sometimes may be relieved by posture, placing the patient upon the corresponding side. Forward obliquity should be overcome with a suitable abdominal binder. In the presence of vigorous uterine contractions with no progress, excessive thinness of the lower uterine segment is to be suspected and examined for. When Bandl's ring is felt more than half-way from the pubes to the umbilicus, labor should be ended as speedily as possible. The procedure to be adopted will depend upon the conditions present. In all cases an anæsthetic, preferably chloroform, should be administered to the full surgical degree to secure complete relaxation of the uterus. The uterus must be emptied promptly and with the least possible violence.

In transverse presentation, child living and not impacted, the cervix fully dilated or dilatable, version may be attempted. In conditions unfavorable for version, decapitation may be performed or, if the child is living and viable, Cæsarean section may be considered.

In head presentation, if the child is living and the head has already engaged, the cautious use of forceps may be tried; but if difficulty is experienced in applying the blades the attempt should be abandoned. Two methods of procedure are then left to the obstetrician—Cæsarean section or craniotomy on the living child. While the latter alternative should be adopted with reluctance if the child is viable, consideration for the interests of the child should not be permitted to further imperil the life of the mother. When the proof of the child's death is conclusive, embryotomy is clearly indicated. Podalic version should rarely be attempted, owing to the danger of rupturing the overstretched uterine walls.

Of Incomplete Rupture. In incomplete rupture, if the fœtus is living and the cervix fully dilated, the child should immediately be extracted by forceps. Version is rarely permissible. When dilation is not complete resort may sometimes be had to manual dilation; exceptionally Cæsarean section may be required. In the interest of the mother the dead child is best delivered by embryotomy.

After delivery of child and placenta per vaginam, if laceration is not extensive and there is little or no bleeding, usually the rent may be trusted to evacuation of blood-clots and drainage. A firm pack of plain or of oxid-of-zinc gauze may be placed in the uterus and an abdominal binder tightly applied for counter-pressure. Uterine contraction may be stimulated, if necessary, by ergot. In any event the case is to be watched for hemorrhage. The pack is removed within three days.

In extensive subserous rupture the abdomen, as a rule, should be opened. Suture, supravaginal amputation, or total hysterectomy may be elected, as conditions may require. When the injury is not too great and there is reason to believe that the uterus is not septic, suture may be practiced. If the uterus is badly injured or is septic, especially in women near the menopause, hysterectomy is the better expedient.

When there is difficulty in determining the extent of the injury or in deciding whether the rupture is complete and possibly complicated with intraperitoneal hemorrhage, the writer has opened the cul-de-sac and explored the serous surface of the uterus.

Of Complete Rupture. When the child has not escaped into the peritoneal cavity, if living and viable, it may be extracted with forceps. Version should not be attempted for fear of extending the injury. If the child is dead, as a rule, embryotomy should be performed. The placenta, if still in the uterus, should be removed manually. When the child has been partly extruded into the peritoneum it is rarely advisable to deliver by the natural passages, except when possible with the utmost facility, and the condition of the mother is such as to forbid laparotomy.

Small lacerations may sometimes be treated by drainage when situated in the lower part of the posterior uterine wall, when not bleeding and when the peritoneum is free from blood-clots, liquor amnii, and meconium. The method is similar to that employed in incomplete rupture. An obvious objection to it is the thin cicatrix which results and the consequent danger of rupture in subsequent pregnancy.

If the fœtus has escaped wholly into the peritoneal cavity laparatomy usually is imperative. Yet in one or two instances in which the posterior vaginal wall was extensively torn the author has removed the child by extraction through the vagina.

Generally the best results in complete rupture have been obtained by laparotomy. It is always difficult to know the extent of the injury and whether an intraperitoneal hemorrhage has occurred or is still going on till the peritoneum is opened. Even when no material bleeding has taken place late hemorrhage is possible. For these reasons Whitridge, Williams, and certain other writers hold that the abdomen should be opened in every case of uterine rupture regardless of its character or extent, whether complete or incomplete.

When the injury is not extensive and the uterus not septic, good results may be expected by suturing the laceration in the manner practiced in Cæsarean section and making a careful peritoneal toilet.

In more extensive lacerations, or when there is reason to believe that the uterus is infected, total or partial hysterectomy is demanded.

When the peritoneum is much soiled, drainage through the vagina may be maintained for a few days.

RUPTURE OF THE SYMPHYSIS PUBIS.

Swelling and softening of the ligaments and cartilages of the pelvic joints occur in slight degree during pregnancy; especially is this true of the symphysis pubis.

The softening, even at the latter joint, is usually so insignificant as to

give rise to little or no appreciable separation; exceptionally it is sufficient to result in perceptible mobility of the pubic bones upon each other. Separation may result from disease or from violence during operative efforts at delivery; the former accident is known as relaxation of the joint; the latter, which is by far the more common, as rupture of the symphysis.

Causes. Spontaneous rupture of the symphysis is rarely possible. In the great majority of instances the rupture is due to forceps. Excessive or misdirected traction is most frequently responsible for the injury. Of 23 cases of rupture of the symphysis collected by Havajewicz, forceps had been used in 18.

Diagnosis. When rupture of the symphysis occurs during labor the patient may experience a sharp pain in the joint. There may be a sensation of tearing. A sudden advance of the presenting part usually attends the rupture. Usually the mobility of the bones is perceptible to the patient on turning in bed during convalescence. In rare instances the patient may be unaware of the injury to the symphysis until she attempts to walk. In extreme separation of the pubic bones there may be evidence of injury to one or both of the sacro-iliac articulations.

The diagnosis is made by direct examination. With the index-finger introduced within the vagina behind the symphysis and the thumb in front, the separation and mobility of the bones may readily be made out. The looseness of the joints is detected by alternately flexing and extending one thigh and by rotating it outward, while the other is firmly held by an assistant. After the patient is able to leave the bed the slightest mobility is appreciable by examination in the standing posture, the patient being required to rest her weight on one and the other foot alternately.

The **Prognosis** may be grave if the anterior soft parts including the bladder are torn. It is extremely so if the peritoneum is invaded by the laceration. In neglected cases permanent mobility of the joint may remain, with partial or complete inability to walk.

Treatment. The treatment of rupture or relaxation of the symphysis when discovered at the time of the injury consists in immobilizing the joint for from four to six weeks by means of a firm pelvic bandage. The patient in the meantime must be kept in bed. The hammock bed of Quicrel or of Ayres, as employed in the after-treatment of symphysiotomy, may be utilized. Laceration of the soft parts should be repaired by immediate suture. Neglected cases may be treated successfully by vivifying the articular surfaces with a suitable instrument passed subcutaneously, and immobilizing the joint with a firm spica bandage, with rest in bed for a month or more. If pus forms, the abscess should be evacuated promptly. Wiring the bones together is not necessary and yields no better result.

HÆMATOMA OF THE VULVA AND VAGINA.

Extravasation of blood into the tissues of the vagina and vulva occurs most frequently in the labia majora. Rarely the hemorrhage may extend upward in the paravaginal tissues or backward in the perineum. The hemorrhage may be venous or arterial, usually the former. Most frequently the extravasation begins during the second stage of labor, sometimes during pregnancy, rarely after deliv-

ery. The tumor may become large enough to obstruct the birth, yet it seldom attains any considerable size before the expulsion of the fœtus. The swelling is most commonly observed at one side of the vulva; when within the vagina it is located either upon the posterior or the lateral aspect. Labarie has shown that the site of the tumor is dependent upon the anatomical structure of the part affected. When the hemorrhage occurs beneath the skin of the perineal region the extravasation may extend down the thighs or upward on the abdomen; when beneath the superficial fascia it remains localized. Extravasations which occur beneath the deep fascia of the perineum may extend into either iliac fossa. When the blood is effused between the deep fascia and the peritoneum a hæmatoma may form in the abdomen, extending as high as the umbilicus. When either lateral or posterior wall of the vagina is the seat of the extravasation, the blood collection is limited in extent by the dense fibrous layer surrounding that structure and remains localized.

Frequency. The accident is rare, occurring once in from 1500 to 2000 labors. These estimates do not include cases of comparatively frequent occurrence in which there may be a slight capillary oozing due to a varicose condition of the superficial veins of the vulva.

Etiology. The principal predisposing cause of hæmatoma of the vulva or vagina is the obstruction to the local circulation occasioned by advanced pregnancy. Other predisposing causes are disproportion between the fœtus and the birth-canal, circulatory disease, or morbid changes in the blood.

Anything which acts to increase the pressure in the already greatly distended veins may precipitate their rupture. Common exciting causes are blows, falls, or violent concussion, the unskilful use of forceps, awkward attempts at version, and unusual size of the fœtus. As a rule the accident is spontaneous.

Symptoms. First to attract attention usually is a swelling either at one side of the vulva or within the vagina. Most frequently the tumor appears during the severe pains of the second stage of labor and usually develops rapidly. Upon examination there will be found a tumor, smooth, circumscribed when small, but diffuse when very extensive, and imparting to the finger an elastic feel. Fluctuation may or may not be present. The tumor is generally of a dark, livid color, and ultimately the ecchymosis may involve a large area around it. If the formation of the thrombus occurs before delivery of the child, it may obstruct the birth. When the tumor develops at the close of the second stage of labor its presence may interfere with the expulsion of the placenta or, later, with the lochial discharge. With extensive extravasation the symptoms of internal hemorrhage are present, namely, feeble, rapid pulse, pallor, cold, clammy sweat, dimness of vision, shallow respiration, etc. Finally, if the tumor ruptures, external hemorrhage of greater or less degree may be added to the foregoing symptoms.

Prognosis. Hæmatoma in this situation may terminate as do hæmatomata in other localities: It may be absorbed; it may become encysted and undergo fatty or calcareous degeneration; it may rupture or become infected and suppurate. Suppuration is more likely to follow a spontaneous rupture than an open incision. The prognosis is generally good under proper treatment. The outlook is more favorable when the tumor appears

after delivery. The dangers to which the woman is exposed are hemorrhage, sepsis, and those of instrumental or manual delivery.

Treatment. The prophylactic treatment, in the presence of undue congestion of the venous circulation or of small extravasations during the last weeks of pregnancy, consists in keeping the patient in the horizontal position for most of the time. During labor measures to facilitate delivery are indicated. Usually no premonitory symptoms are observed.

The active treatment will depend upon the size of the tumor, the amount of pressure it exerts, and the time of its appearance. When the tumefaction appears before delivery, and by its size renders the passage of the child's head impossible without spontaneous rupture, an anæsthetic should be administered, the tumor freely incised, all clots turned out, the cavity irrigated with a weak antiseptic solution or with sterilized water, and the hemorrhage controlled by a firm gauze pack, and, if required, hæmostatic sutures. The subsequent treatment will consist in daily irrigation of the wound and repacking with gauze, allowing the cavity to heal from the bottom by granulation. If the thrombus does not appear until after delivery, it is better treated by cold applications and compression, with a view to promoting absorption. The case should be watched carefully and, if spontaneous rupture threatens, the tumor should be opened and treated as detailed above. The cavity, as a rule, becomes septic. Extreme care is needed to prevent systemic infection. In case of excessive blood-loss the acute anæmia is to be treated as in other hemorrhages.

CHAPTER XXII.

THE HEMORRHAGES.

Hemorrhage from Partial Separation of an Abnormally Situated Placenta—Placenta Prævia.

Normally the implantation of the placenta is wholly within the upper uterine segment, and its attachment remains undisturbed till the fœtus is expelled. When its site encroaches upon that portion of the uterus which undergoes dilation in the first stage of labor, the placenta is of necessity partially detached at the onset of labor or earlier, in course

Fig. 369.

Marginal placenta prævia. (Bumm.)

Fig. 370.

Partial placenta prævia. (Bumm.)

of the partial expansion of the lower uterine segment, which takes place during the later weeks of gestation, and hemorrhage follows from the torn bloodvessels. To this abnormal situation of the placenta is given the name *Placenta Prævia*, since the placenta lies partly in advance of the fœtus. To the form of hemorrhage occurring from prævial

placenta, Rigby applied the term *unavoidable* hemorrhage, in distinction from that proceeding from partial detachment of the normally situated placenta, which he called *accidental hemorrhage.*

Varieties. Four varieties are usually described: *Lateral,* in which the placenta extends into the lower uterine segment, but not to the internal os; *marginal,* in which it barely reaches the intestinal os; *partial,* in which the placenta is so placed that it partly overlaps the os after full dilation; and *complete,* in which it will wholly cover the fully dilated os. The term *central* placenta prævia is sometimes employed to designate a central implantation upon the lower uterine segment. But these terms are not all accurately descriptive, and the multiplication of varieties is needlessly confusing. It is sufficient to make two classes of cases: *partial* and *complete* placenta prævia.

FIG. 371.

Complete placenta prævia. (BUMM.)

The Source of the Hemorrhage is the uncovered portion of the placental site, sometimes the placenta as well. Hofmeier has shown that the lower uterine segment is supplied by a branch of the uterine artery which descends from the upper segment. The arrest of hemorrhage from the lower portion of the uterus after labor is largely due to the retraction of the contractile upper segment, diminishing the blood-supply to the lower. Before the expulsion of the fœtus, retraction being incomplete or absent, there is a free exchange of blood between the active and the passive segments; hence the hemorrhage from the bared portion of the lower uterine segment in placenta prævia. A placental cotyledon may bleed while partially detached; after complete separation retraction of the musculature generally controls the vessels.

Frequency. The frequency of prævial insertion of the placenta is usually stated at about 1 in 1000 cases. This estimate corresponds very nearly with the results of Müller's investigation, who found 813 cases reported in 876,432 labors, and with the average statistics afforded by lying-in hospitals. The frequency is several times greater in multiparæ than in women pregnant for the first time.

Structural Anomalies. Owing to the comparative thinness of the decidua in the region of the os internum the prævial portion is less perfectly developed than other parts of the placenta. This gives rise to unevenness in thickness and irregularity of form. Sometimes the placenta presents a

horseshoe shape. There may be isolated cotyledons which are almost completely separated from the main structure.

The thinned portion of the placenta has a comparatively insecure attachment, a fact which increases the tendency to hemorrhage. The rest of the organ often is abnormally adherent. Müller found adhesion in 54 out of 142 cases of placenta prævia.

Etiology. The causes of placenta prævia are not definitely known. The most probable cause is some condition leading to tardy fixation of the ovum, permitting it to fall to the lower segment. Atrophic changes in the decidua, relaxation and subinvolution of the uterus, chronic endometritis, new growths and malformations of the uterus are, accordingly, believed to be factors in the etiology. Consistently with this hypothesis low implantation of the placenta is most frequently observed in women who have borne several children. It is more frequent, too, in proportion to the number of children the woman has borne and to the shortness of the interval between successive births.

Müller finds the cause in arrested abortion. The ovum, he thinks, may be partially separated and displaced by uterine contractions and find secondary attachment lower down. Ingleby found a low insertion of the Fallopian tubes in 2 remarkable cases, in each of which placenta prævia had occurred in several successive pregnancies.

Recently Hofmeier and Kaltenbach have proposed the theory that the anomaly may originate from development of the placenta over the decidua reflexa of the lower pole of the ovum. This affords a possible explanation of a small proportion of cases.

Hart maintains that the human ovum can become engrafted only on a surface denuded of epithelium, and that the ovum may exceptionally meet with such a surface only in the lower uterine segment. Kaltenbach's objection that the ovum could not find lodgement near the cervix, but would rather escape through it and be lost, he thinks, does not hold, since the os internum is practically obliterated by folds of hypertrophied decidua.

Symptoms. Usually there are no symptoms in the earlier months of pregnancy; yet placenta prævia is frequently an unrecognized cause of abortion. Generally the first indication is a sudden hemorrhage of greater or less severity. This may occur at any period of gestation, but is seldom noted except in the later months. The liability to hemorrhage increases with each succeeding month of pregnancy. Much bleeding from this cause is rare before the seventh month; in the vast majority of instances the first attack is observed in the eighth or ninth. It comes on without premonition, and generally without obvious exciting cause. Exceptionally the first hemorrhage follows some unusual muscular exertion. The amount of blood-loss varies with the conditions of the individual case. It is proportionate to the extent of placental separation. It is greater usually the more nearly the prævial attachment is complete and the nearer term the hemorrhage; yet a marginal placenta prævia may exceptionally give rise to copious flooding. From one to three pints of blood may be lost in the first attack in pregnancy, and this quantity may be greatly exceeded during labor. Characteristic of this form of hemorrhage is the fact that the flooding is most profuse in the intervals between the pains. During the height of the pains the blood-supply to the torn vessels is almost wholly interrupted by the contraction of the upper uterine

segment. The first hemorrhage, especially if it occurs during labor, may go on to a fatal termination, or it may cease for a time, to be renewed at any day or hour on further separation of the placenta. But it is not alone the copious outpour of blood that is dangerous. In a certain portion of cases the bleeding is slight but persistent, and if neglected, though at no time large in amount, it may ultimately place the patient's life in grave peril. To the clinical picture are frequently added signs of acute anæmia: pallor, excessive perspiration, skin cold and clammy, respiration irregular, sighing, sobbing, yawning, pulse rapid, thready, compressible; thirst, jactitation, tinnitus aurium, air-hunger, nausea, dimness of vision, and syncope.

Diagnosis. Hemorrhage during pregnancy, and especially in the later months, demands immediate investigation to learn its cause. Recurring hemorrhages near term are generally due to abnormally low implantation of the placenta. This form of hemorrhage must be distinguished from so-called "accidental hemorrhage." The diagnosis must rest on the *physical signs.*

Abdominal Signs. In a certain proportion of cases the location of the placenta, when the implantation is partly on the anterior wall of the uterus, may be made out by palpation over the abdomen. Sometimes the edge of the placenta presents a resisting ring perceptible by the abdominal touch. Within the placental area the fœtal parts are felt indistinctly, owing to the interposition of the placenta between the fœtus and the examining fingers, while elsewhere they are more readily made out.

Vaginal Signs. In placenta prævia ballottement is wanting or difficult, as is also the recognition of the fœtal parts by the vaginal touch, owing to the interposition of the spongy placental tissue between the child's head and the fingers of the examiner. Bogginess of the cervix, usually referred to as evidence of prævial insertion of the placenta, is not always sufficiently characteristic to be of diagnostic value. The only reliable sign of placenta prævia is the stringy feel of the placental tissue as determined by the fingers passing through the cervix. During labor the introduction of the finger presents no difficulty. Before labor if the cervix is not sufficiently open to admit the finger readily, the resistance may be overcome by gentle pressure. To distinguish complete from incomplete placenta prævia the finger is passed well up on each side of the cervix, feeling for the margin of the placenta: if the fully dilated os is entirely surrounded by placental tissue, the placenta prævia is complete; if the finger can be introduced between the margin of the placenta and the wall of the uterus, the condition is one of incomplete placenta prævia.

Prognosis. Placenta prævia is a dangerous complication of pregnancy and labor for both mother and child. Much depends, however, on the degree to which the placenta is prævial, and in general the mortality is capable of great reduction under proper treatment. Churchill and Read place the maternal death-rate at from 25 to 33 per cent. In 67 cases recorded by Barnes, 8.8 per cent. of the mothers were lost. Müller's estimate of the mortality is 23 per cent. for the mothers and 64 per cent. for the children. In 61 cases Murphy had but 2 maternal deaths. Winckel thinks that not more than 5 or 10 per cent. of the mothers should be lost. In 739 collected cases there were 57 maternal deaths in incomplete and 109 in complete placenta prævia. Under modern methods of

treatment the maternal mortality should not exceed the limit stated by Winckel, and the fœtal should not be more than 50 per cent.

The risks to which the mother is exposed are not only those of primary hemorrhage, but also those of operative interference and of sequelæ. Malpresentations and malpositions of the fœtus and prolapsus funis are more frequent in placenta prævia than in normal placental implantation, and there is greater risk of infection during labor, of post-partal hemorrhage, and of thrombotic affections.

The fœtal mortality is mainly due to the effects of placental blood-loss, partly to prematurity.

Treatment. The chief element of danger in placenta prævia is hemorrhage, and the control of hemorrhage is, therefore, the principal indication in the treatment. Here, as in general, while the child's life must not be undervalued, the interests of the mother are paramount. It will be convenient to consider the management of placenta prævia under the following heads:

(1) Before the Fœtus is Viable. The death of the mother from placenta prævia is rare before the end of the seventh month of gestation. In many cases a partially expectant plan of action is permissible till the viable period is reached, in the hope of saving the child. This course is more justifiable in hospital practice, where the woman can be kept under close observation and measures for the control of hemorrhage can promptly be enforced should occasion arise. Quiet and, if need be, rest in bed, must be enjoined. The avoidance of much muscular exertion and of the causes of pelvic congestion is imperative.

If the fœtus is dead the uterus should immediately be emptied. The latter treatment is indicated, too, if the hemorrhage is profuse or persistent. The mother's interests may seriously be imperilled by moderate blood-loss if long continued. The viability of the child is likewise impaired.

(2) After The Fœtus is Viable. The development of the uteroplacental circulation increases with each succeeding month of pregnancy. The danger of hemorrhage in placenta prævia is greater the nearer the case to term.

Partial detachment of the placenta with copious bleeding may occur at any hour and the woman be exsanguinated before medical aid can reach her. In all except simple marginal placenta prævia, with little or no hemorrhage, the pregnancy should be terminated immediately the period of full fœtal viability is reached. From the time labor begins or any considerable bleeding has taken place, the physician should remain with the patient until labor is complete.

If the development of the fœtus has passed the seventh month, premature birth usually entails less risk to its life than repeated placental hemorrhages.

Management of Labor. The safest method of inducing labor in placenta prævia is by the use of the water bag. Best for the purpose is the Voorhees or Pomeroy bag. The latter are no less effective than the Champetier-de-Ribes bag and are not so perishable. The Pomeroy bag has the advantage, too, that the dilating portion of the bag is held in the resisting girdle automatically. When the os uteri is not sufficiently dilated to admit the smallest bag, a firm gauze pack may be placed in

the cervix to remain till the bag can be passed. The introduction of one or two bougies between the membranes and the uterine wall adds to the efficiency of the cervical bag or gauze pack for provoking labor. After the os internum is fully effaced the dilation may be completed manually or may be carried to completion with the hydrostatic bag as circumstances may dictate. The bag better insures control of hemorrhage and is less likely to lacerate the cervix. The hand dilates more rapidly.

Rupture of the Membranes. In marginal placenta prævia, as a rule, hemorrhage may be controlled by rupturing the membranes. On escape of the waters the fœtus is driven down by the uterine contractions and the bleeding is partially or wholly arrested by the pressure of the presenting part. A firm abdominal binder aids in maintaining the pressure. If necessary the uterus may be stimulated to contract or the presenting fœtal pole be crowded into the lower uterine segment by expressio fœtus.

The method is suited only to cases in which the placental insertion encroaches but little upon the dilating zone of the uterus. It is positively contraindicated in conditions which may necessitate version.

In addition to the perforation of the bag of waters the presenting edge of the placenta may be separated from the lower uterine segment. The finger is passed through the cervix and the placental margin peeled up as far as the finger can reach easily. This favors retraction of the lower uterine segment and ligation of the torn vessels.

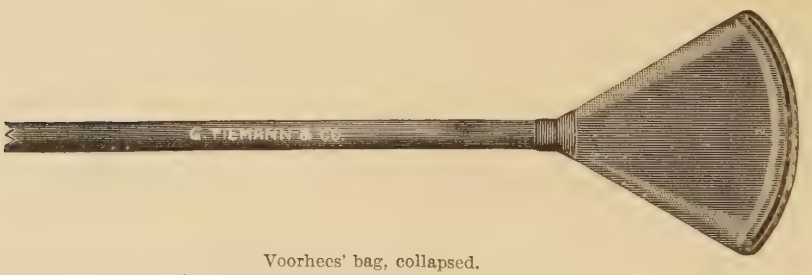
Should this measure fail, a water bag may be introduced, or when the dilation is sufficient the forceps may be applied, if the vertex presents, and gentle traction made to hold the head well down in the lower uterine segment. If the breech presents, one or both feet should be brought down as soon as dilation permits. The conical fœtal mass thus presented acts as an effectual cervical plug. Moderate traction may be used if required.

Vaginal Tamponade. In hemorrhage with little or no dilation of the cervix the vaginal tampon, if properly applied and supplemented by an abdominal binder, usually controls the bleeding. The method of procedure is as follows: The bladder and the rectum are emptied. The Sims, the knee-chest, or the Trendelenburg position is best, since in either of these postures the uterus falls toward the diaphragm and the vagina becomes fully distended with air when the pelvic floor is retracted with the speculum. The material for the tampon may be sterile strip gauze, either plain or impregnated with oxide of zinc. The gauze has the advantage over cotton balls that it may easily be removed. The strip may be three or four inches in width. Whatever the material, it should be wet in order to pack firmly. If the vagina is healthy and has not been infected by previous manipulations, no preliminary internal cleansing is necessary. In all other respects the usual antiseptic precautions must be observed. A convenient instrument for packing the gauze is a straight Keith forceps. The pack is first placed firmly around the cervix. It is then built up from this until the entire vagina is filled and the pack protrudes from the vulva. A pad of absorbent cotton is placed over the external genitals, and over this a firmly applied T-bandage, which holds the tampons securely in place. The vaginal tampon is removed in eight to twelve hours, by which time the labor will in most cases have progressed sufficiently to be managed by other means. Should there still be bleeding,

and the dilation not have progressed far enough to efface the os internum, the packing may be renewed. When properly carried out the vaginal tamponade may be trusted to hold the bleeding in check. It is open to the objection that it is painful and increases the risk of sepsis.

Cervical Tamponade. Most efficient for the control of bleeding in placenta prævia during the beginning dilation of the cervix is the

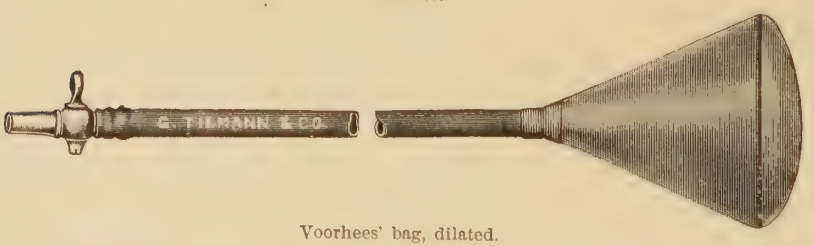
Fig. 372.



Voorhees' bag, collapsed.

complete occlusion of the cervical canal and firm compression of the bleeding vessels of the lower uterine segment. This may be effected by a hydrodynamic bag, which is introduced below or within the amniotic sac and distended with sterile water or the normal saline solution. Suitable for this purpose is the Champetier-de-Ribes ballon, the Voorhees bag (Figs. 372 and 373), or, best of all, the Pomeroy bag[1] (Figs. 374–376). A tube is attached to the bag through which it may be filled. For introduction of the dilating bags the patient may lie in the lithotomy position, the cervix being held well forward toward the pubes with a volsella caught in the anterior lip. One or two fingers are introduced within the vagina and the instrument passed on these as a guide. The Sims position, however, is usually to be preferred. With the perineum

Fig. 373.



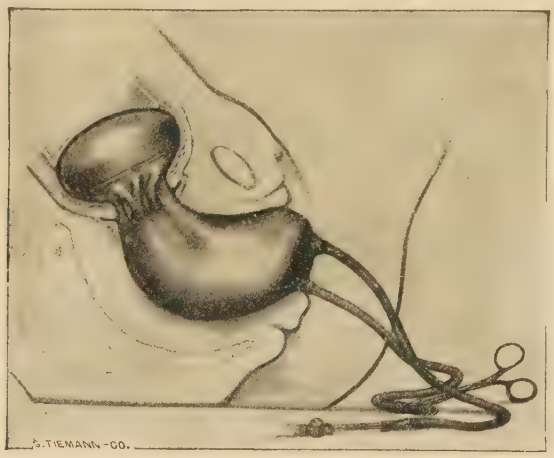
Voorhees' bag, dilated.

retracted by means of a Sims speculum and the cervix drawn forward, the os externum is readily brought into view. The dilating bag is rolled snugly into a cylindrical shape, seized with a long forceps, and introduced through the cervix. The forceps is then withdrawn and the bag distended. As a precaution against infection, should the bag accidentally be ruptured, boiled water or normal saline solution should be used for

[1] The Pomeroy bag is divided by a transverse septum into two compartments or segments. Each segment has its own tube, through which it may be distended independently of the other. The upper segment is passed within the cervix above the resisting girdle and dilated. The lower segment rests in the vagina. Distention of the latter gradually pulls the conical upper segment through the cervical ring.

filling the bag. Air is unsuitable, owing to the risk of air embolism should the bag burst. The injection is made with a Davidson or similar bulb-syringe provided with a nozzle which fits the tube. As a precaution against overdistention the operator should know by previous trial

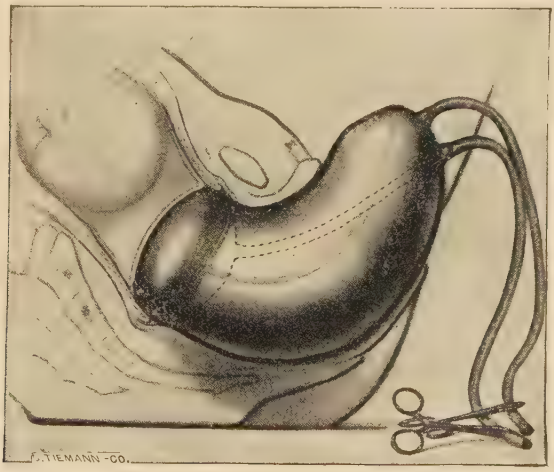
FIG. 374.



Pomeroy's bag.

how many bulbfuls are required to expand the bag to its limit. A rigid asepsis must, of course, be observed.

FIG. 375.

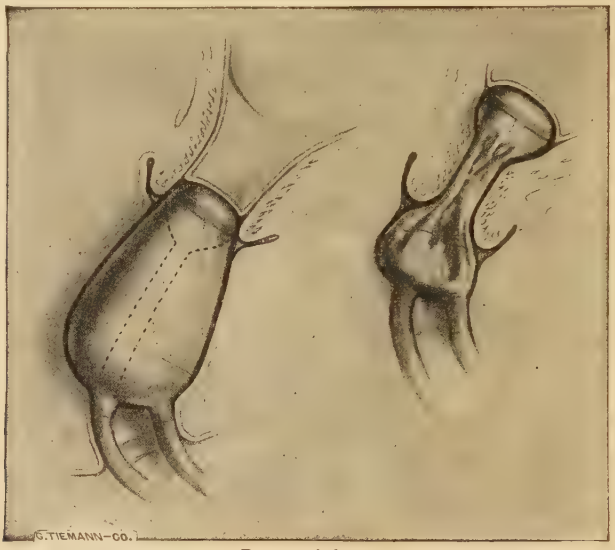


Pomeroy's bag.

The cervical tampon has the double effect of controlling hemorrhage and at the same time promoting the dilation of the cervix more effectually than does the vaginal pack, and it causes less discomfort to the patient. When thought necessary both these measures may be employed. If

required they may be replaced by other measures after the os internum is effaced. This is usually accomplished in eight or ten hours at most.

FIG. 376.



Pomeroy's bag.

When time permits, the labor may satisfactorily be completed with the aid of the dilating water bag.

The cervical or the combination of cervical and vaginal tamponade is especially suited to cases of undilated and rigid cervix with much hemorrhage.

MANUAL DILATION. Manual dilation is seldom permissible, except for completing the canalization of the utero-cervical zone after it is already well begun. To a woman who has sustained much blood-loss, forcible and rapid dilation of the cervix is dangerous, owing to the shock involved. A considerable hemorrhage must necessarily occur during the dilation, and the fingers in the cervix afford imperfect means for controlling it. It must be remembered, too, that the danger of uterine rupture and of infection is increased in low implantation of the placenta, and manual dilation demands unusual skill and care. Instrumental dilation with metal dilators exposes to still greater risk of dangerous traumatism than does the manual method.

Podalic Version. One of the most effectual measures for tamponing the cervix and the lower uterine segment in placenta prævia is podalic version. With one or both feet brought down the fœtus serves as a conical plug, which is forced down or can be drawn down as fast as the dilation progresses. The cervix is thus securely tamponed during the entire course of the birth. Lomer, of Berlin, reports a maternal mortality of $4\frac{1}{2}$ per cent. in 101 cases treated by version. It must not be forgotten, however, that any kind of violent intervention is unsafe when the woman has lost much blood. If, therefore, free bleeding has occurred, version is to be undertaken only when little difficulty is likely to be encountered.

In most cases, especially after much hemorrhage, it is a grave mistake to add the shock of immediate delivery to that of version. The best results of version in placenta prævia have been obtained only when the operation has not been followed by immediate extraction. Either the external, the bipolar, or the internal method may be chosen, according to the conditions present. External version before labor is exceptionally possible. The bipolar method of Braxton Hicks has the advantage over internal version that it may be performed early in the labor, as soon as two fingers can be passed through the os uteri, and there is less danger of infection than when the whole hand is introduced. The fingers passed through the membranes, one or both feet are seized with the hand and brought down. When the placental margin cannot readily be reached, in emergency the placenta may be perforated and the feet drawn down through the rent. With the fœtus inverted the hemorrhage is completely under control and the delivery can usually be left to nature. Moderate traction may be required when the uterine contractions are not sufficiently vigorous. Rarely it may be necessary to assist the birth, taking plenty of time, delivering very slowly.

The results for the child are not so good in version as with hydrodynamic dilation. When the child is dead or non-viable version may be preferred to water bags in conditions suitable for version, or delivery may be facilitated by perforation of the head.

For the full technique of the different methods of version the reader is referred to the chapter on Obstetric Surgery.

Other Methods. *Partial Separation of the Placenta.* Separation of the presenting portion of the placenta, as proposed by Barnes, often suffices in marginal implantation. It permits retraction of the zone uncovered. In many instances of this form of placenta prævia no other treatment will be required. One or two fingers are passed between the placental edge and the uterine wall, and the margin of the placenta is peeled up by sweeping the fingers laterally. The detachment should be carried far enough to uncover completely the dilating zone of the uterus. An abdominal binder should be applied.

Complete Separation of the Placenta, as advised by Simpson, is applicable in case the child is dead or not viable.

Cæsarean Section. Cæsarean section, first proposed by Tait, can very seldom be justified in placenta prævia. After much blood-loss and when the woman is in bad condition, so serious an operation is clearly contraindicated. When the condition is good the usual obstetric procedures, as a rule, are competent for hemostasis and for safe delivery and the major operation is uncalled for. The prognosis for the child is not materially improved by Cæsarean section since the fœtal mortality is largely due to prematurity.

Precautions. It must not be forgotten that the essential object of treatment in placenta prævia is the control of hemorrhage. Hemorrhage under control, there is no occasion, as a rule, for active measures. Violent intervention is especially contraindicated in the acute anæmia which often obtains in this class of cases at labor. Frequently very little shock in such conditions will precipitate a fatal issue. A large proportion of deaths in placenta prævia is distinctly chargeable to over-zealous interference.

Owing to the low placental site and the intra-uterine manipulations usually required, the risk of sepsis, too, is much greater than in ordinary labors. Precautions against sepsis must rigidly be observed.

Post-partum hemorrhage is of frequent occurrence. The vessels of the placental site are not so securely ligated after labor, when the implantation is on the lower and less contractile portion of the uterus, as in normal conditions. The amount of post-partum flow must always be watched. Retraction of the uterus should promptly be secured and rigidly maintained. Ergot should be given for two or three days after labor.

HEMORRHAGE FROM PREMATURE SEPARATION OF A NORMALLY SITUATED PLACENTA—ACCIDENTAL HEMORRHAGE.

Hemorrhage may occur during labor or the later weeks of pregnancy as the result of premature partial or complete detachment of a normally seated placenta. To this form of bleeding Rigby, as already explained, applied the term accidental hemorrhage. Holmes would call it *ablatio placentæ*.

Hemorrhage of this character is exceedingly rare. It is generally believed to occur not more than once in 8000 or 10,000 labors. Goodell, in 1870, had collected but 106 cases. Holmes reports 200 additional cases collected from various sources. He is led to conclude that the accident occurs oftener than most writers have assumed.

In a certain proportion of cases the area of placental detachment may be so small as to result in no hemorrhage of pathological importance. Examination of the placenta at the close of labor sometimes reveals a small quantity of old retroplacental blood-clot which has caused no symptoms.

Varieties. Two varieties of accidental hemorrhage usually are described: *Apparent* and *concealed* or *internal hemorrhage*. In the first variety the blood finds its way between the membranes and the decidua, and escapes through the cervix; in the second, the blood fails to find an outlet, and may collect in sufficient quantity within the uterus to occasion alarming symptoms or even death, with no visible bleeding. The former variety is the more frequent.

In the concealed form, according to Goodell, either of the following conditions may obtain: 1. The placenta may be detached at the centre, the margin being still adherent. 2. The placenta may be detached at one edge, the membranes being separated for a short distance beyond the placental margin. 3. The edge of the placenta and the adjacent portion of the membranes being detached, the latter may rupture, permitting escape of blood into the amniotic sac. 4. Detachment of the placenta may take place, accompanied with separation of the adjacent membranes, but the fœtal head or a blood-clot in the cervix may prevent external escape of the blood.

While the first attack of hemorrhage may occur after labor has commenced, almost invariably it takes place during the later weeks of pregnancy.

Etiology. The etiology is similar to that of abortion. Probably the chief primary cause of premature detachment of the normally situated placenta is to be found in diseased conditions of the decidua or of the placenta itself. These may be the result of syphilis, gonorrhœa, neo-

plasms, arteriosclerosis, nephritis, extreme anemia, diabetes, or of certain acute infectious diseases, as scarlatina, diphtheria, or variola. Certain anomalies of the fœtal appendages, great distention of the uterus and short cord, may favor premature separation of the placenta. The accident is much more common in multiparæ than in women pregnant for the first time. The loosening attachment of the placenta normal to the later weeks of gestation must be taken into account in defining the etiology.

In the presence of conditions which favor separation of the placenta, mechanical disturbance even though seemingly trivial may precipitate the accident. Thus, blows on the abdomen, falls, jars, and violent muscular exertion must be counted among the causes of accidental hemorrhage. In favoring conditions, sudden retraction of the uterus, as may happen in twins after the birth of the first child or in hydramnios on escape of the waters, may cause premature detachment of the placenta.

Diagnosis. Apparent Variety. The existence of hemorrhage is obvious. Rupture of the uterus and placenta prævia must be excluded. The former occurs later in the labor than does accidental hemorrhage, and is characterized by recession of the presenting part, diminution of the uterine tumor, and the development of a new abdominal tumor; placenta prævia is readily differentiated by a physical examination. In accidental hemorrhage the uterine tumor is increased in size and the flooding usually takes place before the rupture of the membranes. Pain, often extreme, may be present owing to accumulation of blood-clots within the uterus.

Concealed Variety. First to attract attention usually are the systemic effects of hemorrhage. If the blood effusion is extensive, the fact is betrayed by marked pallor, anxious expression of countenance, cold extremities, feeble and rapid pulse, sighing respiration, dyspnœa, collapse, and other signs of internal hemorrhage. The uterine contractions are weak, yet often continuous uterine pain is present, owing to distention of the perimetrium. Profound shock may result from uterine distention even, with little or no pain.

On abdominal examination, a node or boss on the uterine wall may be noted at the seat of the blood collection; in atonic conditions of the musculature the uterine tumor presents a boggy feel and in all cases after much hemorrhage the fœtal parts are indistinctly felt, and the fœtal heart-sounds are feeble and irregular or absent. The uterine tumor rapidly increases in size. The condition may sometimes be detected by pushing up the presenting part and allowing a portion of the blood and liquor amnii to escape. It should not be forgotten that concealed may coexist with an insignificant external hemorrhage. Leakage of bloody serum indicates a clot in the uterus. This is almost absolutely diagnostic of accidental hemorrhage.

Concealed accidental hemorrhage may be confounded with ruptured tubal pregnancy, but usually the latter is readily distinguished by physical exploration and by its history.

Prognosis. The prognosis obviously must vary with the extent and rapidity of the hemorrhage. Much, too, depends on the possibilities for prompt evacuation of the uterus. The gravity is much greater with a rigid and undilated cervix than when labor is well advanced.

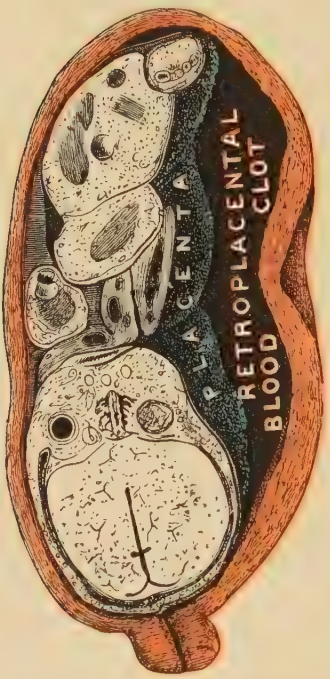
In Godell's cases the maternal mortality was 41.3 per cent. in open

and 52 per cent. in occult hemorrhages. Holmes, in 150 apparent and 39 concealed hemorrhages, found the maternal death-rate 34.6 and 23 per cent. respectively.

About 85 per cent. of the children are lost.

The high death-rate in case of the mothers is due to blood loss, sepsis, post-partum hemorrhage, and to shock and exhaustion from over-distention of the uterus. The fœtal mortality arises chiefly from asphyxia, the result of interruption of the utero-placental circulation. Prematurity is sometimes a contributing factor.

FIG. 377.



Frozen section of the uterus of a woman who died of accidental hemorrhage at the Maternité de Beaujon. (PINARD and VARNIER.)

Treatment. In the external variety of hemorrhage, if the bleeding is moderate in amount, the mother's condition being fairly good and the fœtus still viable, the only treatment demanded is rest in bed, a full dose of opium, and absolute quiet for a week or ten days. Even a moderately free hemorrhage may sometimes be arrested by these means.

In either variety, when the blood-loss is alarming, the uterus must be emptied. If the os is fairly well dilated the membranes may at once be ruptured. If the os is small and rigid, dilation should be initiated with a metal dilator and completed manually. A firm abdominal binder helps to prevent further accumulation of blood in the uterus. Uterine contractions are stimulated by massage and by the hypodermic use of ergot; ½ drachm of the fluid extract may be given every twenty minutes till its full effects are obtained. After full dilation labor should be terminated as speedily as possible by version or forceps.

When, with cervix undilated, immediate delivery is demanded, recourse may be had to multiple incisions of the cervix or, in extreme cases, to Cæsarean section. As a rule this is best done by the vaginal route after the method of Dührssen.

If the child is dead and the os sufficiently dilated or easily dilatable, in most cases delivery may be effected with the least loss of time and with least shock to the mother by craniotomy.

If the patient's condition is such as to forbid active obstetric intervention the foot of the bed may be elevated and time given to rally before subjecting her to the additional shock of operation. Saline infusion and all measures for stimulating the circulation must be withheld till bleeding is under control, lest they increase the hemorrhage. The relaxed uterus should be made to contract by means of friction or compression of the fundus, a firm abdominal compress, and the free administration of ergot by the hypodermic syringe.

The after-treatment consists in measures intended to promote uterine contractions and in the treatment of acute anæmia. The woman is especially liable to post-partum hemorrhage. For the latter complication the treatment, both prophylactic and remedial, is the same as under other conditions.

The shock and collapse are to be combated with adrenalin (10 or 15 minims of a 1 : 1000 solution), given hypodermically every hour, and by submammary or intravenous injections of normal salt solution. The best effects of adrenalin are to be had by giving it intravenously. It may be added to the saline infusion. Elevating the foot of the bed and auto-infusion, by bandaging the extremities, are useful expedients.

POST-PARTUM HEMORRHAGE.

Etymologically, the term post-partum hemorrhage applies to hemorrhage arising at any time after the birth of the child and from whatever cause. In its technical sense the term is restricted to hemorrhage from the placental site occurring within the first twenty-four hours after the birth of the child. In the great majority of instances the bleeding takes place before or immediately after the placenta is expelled.

The term "secondary post-partum hemorrhage," or puerperal hemorrhage, is applied to flooding coming on after the first twenty-four hours of the puerperium.

Hemorrhage from rupture or inversion of the uterus, malignant or benign growths of that organ, or from lacerations of the cervix or vagina, are not included under post-partum hemorrhage in the technical meaning of the term.

Frequency. The records of hospitals and large lying-in institutions, from which statistics are mainly gathered, and in which the labors are conducted presumably by men of special skill, naturally show a smaller frequency of post-partum hemorrhage than is observed in private practice. Playfair considers post-partum hemorrhage of some degree one of the commonest complications with which the obstetrician has to deal. On the other hand, the records of Guy's Hospital furnish but 1 case of dangerous post-partum hemorrhage in 2040 labors; St. Thomas's Hospital reports give 1 in 2172 labors; Veit, from the statistics of a number of Continental authorities, was able to collect only 5 fatal cases in 47,765 deliveries. This latter statement certainly underestimates the death-rate from this cause. In general, it may be stated that mild post-partum hemorrhage occurs once in 50 to 100 labors; severe, once in from 1000 to 1200; and fatal, once in from 4000 to 6000 labors.

Etiology. *First.* The essential factor in post-partum hemorrhage is imperfect retraction of the uterine muscles. Normally, with the separation of the placenta, there is a certain amount of blood-loss, which, however, is quickly controlled by the firm contraction of the uterus; the uterine sinuses are closed by the contraction of the network of muscular fibres with which the bloodvessels of the uterus interlace. Hemorrhage of any considerable amount cannot take place from the cavity of a normally contracted uterus.

There are numerous remote causes which contribute directly or indirectly to imperfect uterine retraction at the close of labor. Prominent among these is exhaustion following a prolonged and difficult labor.

After precipitate labor and sudden expulsion of the child, flooding may occur before time enough has elapsed for uterine retraction to take place. Overdistention of the uterus, as in hydramnios, multiple pregnancy, etc., frequently results in uterine inertia; a distended bladder or rectum tends to inhibit normal uterine contractions. The retention of placental fragments which are partially adherent may prevent full uterine retraction and the secure ligation of the vessels. New growths in the uterus may have a like effect. Profound anæsthesia long continued tends to more or less complete atony of the uterus. Certain systemic diseases predispose to hemorrhage after labor, such as nephritis, extreme anæmia, etc. Hemorrhage at the close of labor may be precipitated by sudden emotional disturbance. Inertia uteri, in the final as in the earlier stages of labor, is more common among the well-to-do than among the poorer classes, owing to luxurious habits, lack of exercise, and general laxity of the muscular system, which is the rule among the former. Failure of retraction is more frequently observed in women who have borne many children and in whom there is increased connective-tissue growth between the uterine muscle fibres, or in old primiparæ who are much debilitated. Veit refers to localized paralysis at the placental site as an occasional cause of post-partum hemorrhage. Very rarely hemorrhage may arise from rupture of an aneurismal vessel, or a varicose vein, or a cervical hæmatoma.

Second. Placenta prævia exposes to post-postum hemorrhage. The lower segment of the uterus has little contractile power at the close of labor. Hence, after complete separation of the placenta from the lower uterine zone, bleeding may follow from the relaxed lower uterine segment.

Third. Rarely the hemorrhagic diathesis is encountered in obstetrics as in other fields of practice. Here the gravity of the complication is due more to the persistence of a moderate hemorrhage than to profuse flooding.

Diagnosis. The bleeding may occur before or after the expulsion of the placenta. It may be gradual or abrupt. The bleeding may be external, internal, or both. Often there may be considerable accumulation of blood within the uterus. One of the most notable effects of hemorrhage is lessened force and increased frequency of the pulse. A high and rising pulse-rate following delivery is always significant of possible hemorrhage. A patient with a pulse remaining at 100 or more after labor should constantly be watched till all danger of flooding has passed.

In extreme cases the pulse becomes almost imperceptible. The respirations are shallow and rapid or gasping; the patient tosses about the bed and complains of air-hunger and thirst. The skin may be cold and covered with a clammy sweat. Syncope usually is conservative, since it favors thrombosis in the uterine sinuses and arrest of the bleeding. If the hemorrhage persists, loss of consciousness, convulsions, and death quickly follow.

The existence of external hemorrhage is obvious. In concealed bleeding the condition is recognized by the presence of some of the above-mentioned symptoms. With the hand placed on the abdomen, instead of feeling the uterus as a hard globular tumor between the umbilicus and

the symphysis, it will be found soft, boggy, and extending perhaps above the umbilicus; not infrequently no uterine globe can be made out.

It is especially important to distinguish between bleeding from the placental site and hemorrhage from other sources. When the bleeding proceeds from injuries to the birth canal it immediately follows the expulsion of the child. Hemorrhage which persists in the presence of a firm uterine contraction after the expulsion of the placenta does not come from the placental site. Careful search should be made for lacerations. Hemorrhage beginning several minutes after the birth of the child is probably due to imperfect uterine retraction. The possible retention of placental fragments or of an isolated placental cotyledon may be detected by examination for defect in the placenta or membranes. In the one case a portion of the placental tissue will be lacking, in the other a circular rent will be found in the membranes at the former seat of the isolated placental lobe. Leakage of bloody serum usually indicates a blood-clot in the uterus.

Prognosis. The prognosis will depend upon the amount of blood-loss and the nature of the causes which have led to it. Yet endurance differs much in different patients and in different conditions of the same patient. The most unfavorable cases are those in which, though the hemorrhage is not severe, the blood is light colored, contains no clots, and is indicative of a blood dyscrasia. Bumm observes that extreme dyspnœa is a worse prognostic than pulselessness. If the hemorrhage can be arrested while there is still some power of reaction, the prognosis usually is good. Recovery after severe post-partum hemorrhage is slow, and it may be weeks or months before the patient regains her usual vigor.

Treatment. Prophylaxis. Serious post-partum hemorrhage is, for the most part, preventable. The preventive treatment must be directed to the uterine retraction. In all cases the hand of the obstetrician or an assistant should be held on the abdomen over the uterus from the moment the child is born till the placenta is expelled; and after the expulsion of the placenta the uterus should be watched for at least an hour, in the same manner, by the physician. Any tendency to abnormal relaxation should immediately be combated by friction or, if need be, by more active manipulation. When the uterine contractions are feeble, ergot should be given by the mouth or hypodermically. Ordinarily a sufficient dose is ½ drachm of the fluid extract repeated hourly till retraction is fully established. This precaution is especially advisable after chloroform anæsthesia. Finally, a firm abdominal binder may be used to maintain uterine retraction. When special precautions are needed, compresses consisting of folded towels may be placed under the bandage, one on either side of the uterus and one immediately above it. When the management of the third stage is properly carried out, the occurrence of grave hemorrhage must be exceedingly rare.

Active Treatment. The occurrence of post-partum hemorrhage demands prompt and vigorous measures. The obstetrician should be so familiar with the resources for the arrest of uterine hemorrhage that no time may be lost in deciding upon the choice of procedure. All needed preparations should be ready for instant use should abnormal bleeding occur.

If the placenta is still in the uterus it should be expressed by the

method of Credé or, if need be, removed by the use of the hand or of one or two fingers in the uterus as a last resort.

Faradization. One of the most effectual measures for promoting energetic uterine contractions is faradization of the uterus. An electrode may be applied upon the abdomen over each side of the uterus or one upon the abdomen over the uterus and the other over the upper sacral region.

Compression of the Aorta. Compression of the abdominal aorta is useful as a temporary expedient. It can easily and quickly be applied and it often serves to gain time for other procedures. The arterial anæmia of the uterus caused by interruption of the blood supply induces vigorous contractions.

Make the Uterus Contract. On the occurrence of hemorrhage of the kind under discussion after placental expulsion the paramount indication is to secure uterine contraction. The patient should be placed on her back, the pillow removed from beneath her head, and the foot of the bed elevated. All this may be done by an assistant. The hand placed flat upon the abdomen moves the abdominal wall in a circular direction over the uterus and the organ is vigorously kneaded. After the uterus becomes slightly contracted, so that its outline is defined, the fingers are pressed deeply into the abdominal wall behind the uterus, while the thumb remains resting over the anterior surface. Thus the fundus of the uterus rests in the palm of the hand, by which it is to be forcibly grasped. If necessary, both hands may be used. Vigorous compression tends to expel clots and to control the hemorrhage.

Hand in the Uterus. In profuse or persistent hemorrhage one hand may be introduced into the uterus. With the internal hand closed, the other held over the abdomen, the uterus may be compressed between the two hands. Raking the uterine wall vigorously with the finger-tips is an effectual method of exciting contraction. The hand should be gloved. Owing to the grave danger of infection the introduction of the hand within the uterus should be avoided if possible. It is permissible only when other measures have failed or are not available.

Compression of the Uterus. Hamilton suggests passing the fingers of one hand well back into the posterior cul-de-sac of the vagina, while the external hand, grasping the fundus through the abdominal wall, makes counter-pressure. The uterus is thus strongly anteflexed. Sometimes, instead of this, the uterus may be crowded down with one or both hands on the abdomen and compressed against one iliac fossa. (Fig. 378.)

General Measures. While the physician is thus engaged in stimulating uterine contraction, he may direct the nurse or assistant in the use of other measures. A full dose of ergot should be given hypodermically. In the presence of exhaustion, systemic stimulation will be demanded: $\frac{1}{20}$ to $\frac{1}{15}$ grain of strychnine may be administered hypodermically; a full dose of morphine is a valuable measure. The child should at once be put to the breast, since nursing provokes uterine contractions.

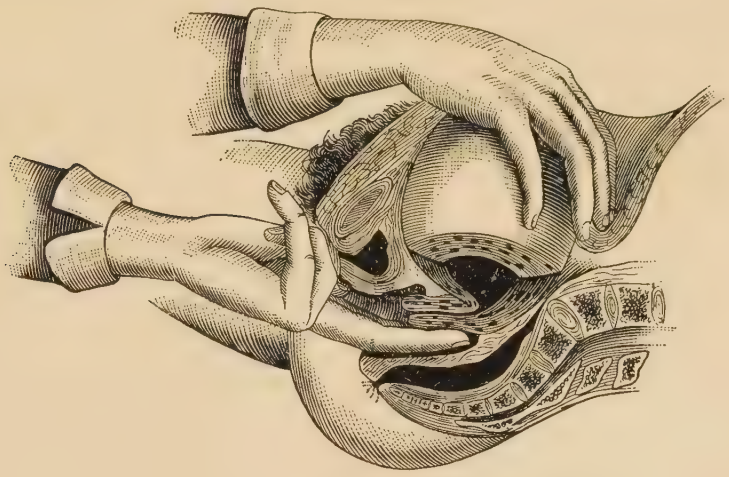
Intra-uterine Styptics. Even in the time of Hippocrates we find mention of the employment of various chemical and mechanical irritants in the cavity of the uterus for the purpose of exciting uterine contractions and the arrest of bleeding. The introduction of ice into the uterus, while often effective, is a doubtful expedient from the standpoint of

asepsis. The application of dilute acetic acid or of alcohol within the uterine cavity is a powerful excito-motor. In emergency either of these agents may be utilized by saturating a piece of sterile gauze with it and passing the gauze into the uterus.

Barnes' intra-uterine injection of perchloride of iron solution is not to be recommended. Not only is the woman exposed to the danger of pulmonary embolism, but a mealy mass of blood-clots is left in the uterus, which may serve as a nidus for the growth of putrefactive and pathogenic bacteria.

The intra-uterine injection of hot sterilized water has come to be regarded as one of the most reliable means for the control of post-partum hemorrhage. The external genitals should be well smeared with carbol-

FIG. 378.



Bimanual compression producing anteflexion. (SCHROEDER.)

ized vaseline or olive-oil to relieve pain from contact of the hot water with the skin. After removing placenta and clots from the uterus and vagina, a long douche-tube, preferably of glass and with openings only at the extreme end, is carried to the fundus. Several gallons of water are injected at a temperature of 48° C. (120° F.) or as hot as can be borne. The temperature of the water should not exceed 125° F., lest the uterine muscle be paralyzed. Neither should it be below 115° F., as merely lukewarm water favors hemorrhage. The temperature should be determined accurately by a bath thermometer. Either a fountain or a Davidson syringe may be used. The addition of acetic acid greatly enhances the hemostatic effect of the hot irrigation: 3 per cent. or more may be used, 4 ounces or more to the gallon.

Intra-uterine Gauze Pack. Simple measures failing, the uterus should be tamponed with strips of aseptic gauze; this procedure, if properly carried out, will control hemorrhage which resists all other measures. The method is as follows: Three strips of plain sterilized gauze are provided, each three inches wide and about ten feet in length. The patient lies on her back across the bed in the lithotomy position,

the thighs being supported by an assistant. Each lip of the cervix is seized with volsella forceps or a tenaculum and drawn down toward the vulva. An assistant holds the tenaculum. The operator now makes pressure on the fundus of the uterus with one hand, while with the other he grasps one end of a strip of gauze in a long uterine dressing-forceps and carries it to the fundus of the uterus. The use of the external hand upon the abdomen is essential to make sure that the pack reaches to the fundus. Successive layers of gauze are now deposited one on the other with moderate firmness until the uterus is completely filled. The ends of the gauze may be left projecting into the vagina, in which a little gauze may be loosely placed. If strict aseptic precautions have been observed, the tampon may safely be left in the uterus twenty-four hours. Renewal of the tampon is very seldom required. The efficacy of the uterine tamponade may be increased by saturating the gauze with a strong alum or weak acetic acid solution.

Treatment of Acute Anæmia. The principal measures for combating the effects of severe blood-loss are transfusion, auto-transfusion, subcutaneous, submammary, and intravenous injections of the normal salt solution, and rectal injections of this solution.

Transfusion, or the introduction of blood from one person directly into the venous circulation of the patient, is a method formerly much in vogue, but now no longer practiced.

Auto-transfusion consists in forcing the blood from the extremities into the trunk and brain and retaining it there by bandaging the extremities. An Esmarch bandage may be applied to one arm, beginning at the fingers, and one to the opposite leg and thigh, beginning at the toes. Only two extremities should be constricted at once. These bandages may be left on twenty minutes to half an hour, and before their removal the opposite leg and arm should be bound in the same manner. By thus alternating the constriction, the danger of thrombosis and embolism is diminished.

The normal saline solution, introduced into the circulation either directly by venous infusion, subcutaneously, or by high rectal enemata, is a measure of great value. The normal saline solution consists of a solution of sodium chloride of the strength of nine-tenths of 1 per cent. in sterilized water; before using it should be raised to a temperature of 37.5° C. (98°–100° F.) and filtered through absorbent cotton. This solution may be prepared with sufficient accuracy by adding a teaspoonful of salt to a quart of water and sterilizing. Subcutaneous injections may be made with Münchmeyer's apparatus or, in the absence of this, by means of an aspirating needle attached to a rubber tube having a funnel or fountain syringe at the other end. Two pints or more of the solution may be used. These injections may be made beneath the skin of the abdomen, thigh, or back, or, better, behind the mammary gland. High rectal enemata of the same solution may be given at frequent intervals and in as large quantities as can be retained. The patient may be encouraged to drink freely of water, yet stomach absorption usually is in abeyance.

Intravenous injections of the normal salt solution are given in the the following manner: A funnel holding a quart, to which is attached a rubber tube terminating in a fine-pointed glass tip or a metal canula, is filled with the previously prepared salt solution, which must be abso-

lutely sterile and free from mechanical particles. The temperature of the solution should be about 37.5° C. (100° F.). The integument over the median basilic vein is now carefully disinfected and the vein made prominent by a snug bandage applied about the arm below the shoulder. An incision 1 inch in length is made parallel with and at one side of the median basilic vein. The vein is now freed from its attachment for a distance of ½ inch with the handle of the scalpel. An aneurism needle threaded with a double silk ligature is introduced beneath the vein, the ligature cut, and the aneurism needle removed. One of the ligatures is drawn into the lower angle of the wound, the vessel ligated, and the ends of the ligature cut away. The second ligature is drawn upward toward the upper angle of the wound and one knot loosely taken. Having the canula or small glass tip now close at hand, with a gentle stream running, the vein is picked up with a pair of dissecting forceps and an oblique upward slit made with the scissors, care being taken not to cut the opposite wall of the vessel. The canula is quickly introduced into the vein, the water running gently all the while, and is retained in position by drawing snugly the single knot of the ligature. The constricting bandage above the field of operation is removed. The amount of solution introduced will vary from one to three pints, dependent upon the condition of the patient. The height at which the glass funnel is held will determine the force of the stream; usually three feet above the patient's body will be sufficient. The infusion should be made slowly. When enough fluid has been introduced, as indicated by the radial pulse, the canula should be withdrawn, the ligature quickly tightened, a second knot taken, and the ends of the ligature cut away. The vein between the ligatures should now be completely divided, the skin incision closed by two or three sutures, and a dressing applied.

Prolonged irrigation of the bowel with the hot saline solution at a temperature of 120° F. has been praised for the treatment of anæmia. A double-current canula is employed. As much as fifteen gallons of the salt solution may be used in this manner. Better results, it is claimed, are obtained than with subcutaneous injections. About one volume in thirteen is absorbed.

The maintenance of the body temperature by artificial heat is especially important.

Convalescence from the anæmia resulting from severe post-partum hemorrhage is tedious. The patient should not be permitted to assume the upright position for some time. Nursing should be prohibited. The patient should not be allowed out of bed for at least four weeks after her confinement. A light but nutritious diet should be ordered. Hematinics, tonics, and other restorative measures are indicated.

Secondary Post-partum Hemorrhage.

Excessive bleeding from the uterine cavity occurring within the puerperal period and later than twenty-four hours after delivery is termed secondary or late post-partum hemorrhage.

Etiology. The principal causes of late puerperal hemorrhage are the following:

Retained Secundines. One of the commonest causes of excessive blood-loss in the puerperium is the retention of placental fragments, a

secondary placenta, or portions of membranes. Hemorrhage does not necessarily always follow. It is most likely to do so when masses of villosities remain for a time partly attached. Normal uterine retraction is impeded and the vessels are not securely ligated. Involution, too, is retarded, the uterus remains unduly vascular, and there is prolonged bloody flow.

Too vigorous use of Credé's manipulation may tear off portions of the placenta and leave them behind in the uterus. This is especially true in undue placental adhesion.

Retention of placental fragments should be detected by examination of the placenta. When an isolated placental cotyledon is left behind in the uterus the fact is revealed by a hole in the membranes near the placental margin.

Retained Blood-clots. The retention of blood-clots is a less potent cause of hemorrhage, and the same is true of *loose* fragments of placenta and membranes. Retained coagula are most commonly observed in multiparæ in whom the uterus usually is more relaxed, and especially when from negligence in the management of the final stage of labor or other cause the uterus has not retracted properly at the close of labor.

Dislodged Thrombi. Rarely hemorrhage may result from dislodgment of thrombi in the uterine sinuses, reopening the veins. This may occur from undue muscular exertion or from getting up too soon.

Neoplasms. Fibromata and malignant disease are possible causes of puerperal hemorrhage. Interstitial or submucous fibroids may interfere with contraction and retraction of the uterus. Prolonged and sometimes very profuse bleeding may occur. With malignant growths the lochia are usually fetid as well as profuse.

Retrodisplacement. In a certain proportion of cases the uterus becomes retroflexed before involution is complete. This often occurs in tardy involution or in metritis. It happens most frequently toward the end of the third week. A return of the bloody lochia at this time, together with backache, is especially significant of displacement. It is important that the position of the uterus be watched during the later weeks of the puerperium. One or more pelvic examinations should be made in the third week and later.

Full Bladder or Rectum. A rectum packed with fæces and especially an overdistended bladder is a common cause of too free and prolonged bloody flow after labor. They act by inhibiting uterine contractions. The urinary secretion is generally much increased after delivery and the bladder may be greatly distended, even when the patient is voiding large quantities of urine. The possibility of partial retention should not be overlooked in the routine examination of the puerperal patient.

Active Pelvic Congestion. Too early resumption of the marital relation may cause pelvic congestion and consequent bleeding.

Systemic Causes. Disease of the lungs, heart, liver, kidney, leading to partial obstruction in the venous circulation, may cause passive pelvic congestion. Defective innervation, acute infectious diseases, and violent emotional disturbance are recognized causes of hemorrhage during convalescence from labor. Rarely relaxation of the uterus from secondary inertia may occur in the subjects of impaired muscular and nervous tone.

Hemorrhage from the placental site must be distinguished from other varieties of hemorrhage, such as bleeding from cervical, vaginal, or perineal lacerations, from ruptured hematoma, inversion of the uterus, etc.

CHAPTER XXIII.

ECLAMPSIA.

Definition. By the terms eclampsia, puerperal eclampsia, and puerperal convulsions is meant, in modern medicine, an acute, morbid condition, making its advent during pregnancy, labor, or the puerperal state, which is characterized by a series of tonic and clonic convulsions, affecting first the voluntary and then the involuntary muscles, accompanied by complete loss of consciousness, and ending in coma or sleep. The disease may eventuate in death or recovery (Charpentier).

Frequency. Eclampsia is most frequent in the later months of pregnancy, less frequent in labor, and least frequent in the puerperium. Its occurrence is given by various authorities as 1 in 500 pregnancies; 1 in 250 to 300; 1 in 350 to 500—a range of 0.2 to 0.4 per cent. It is said that the complication appears in 1 per cent. of all cases of albuminuria of pregnancy. Schauta places it at 0.25 per cent. of all pregnancies.

Symptomatology. Symptoms of eclampsia may be classified as those of the prodromal period, or pre-eclamptic state, and those of the attack. In the latter, moreover, there are three stages: (1) invasion; (2) tonic and clonic convulsions; (3) coma.

Prodromal Period, or Pre-eclamptic State. These symptoms are of great importance, for to the experienced they are a certain sign of an impending attack. As in epilepsy, a well-defined aura may give the warning. Following it, or occurring without it, there may be headache, tinnitus aurium, visual disturbances, such as dizziness, amblyopia, amaurosis, epigastric pain, digestive and nervous disturbances, and a feeling of general debility. These occur with a fair degree of constancy in about one-fourth of all cases of eclampsia. Less often symptoms of involvement of the brain occur, somnolence, stupor or insomnia, vertigo, vomiting, mental excitement, or despondency. All of them may subside, in which case appetite returns, perspiration and diuresis become more abundant, and the patient falls into refreshing sleep. Usually the issue is not so happy, and the premonitory signs, or pre-eclamptic state, after having existed for hours or days, give way to those of the

Stage of Invasion. The eyes stare, the lids twitch convulsively, and the pupils, at first contracted to a pin-point, dilate widely. During the attack they are totally insensible to light. The face becomes cyanotic, and the muscles about the alæ of the nose and the mouth jerk rapidly and convulsively. The mouth is drawn to one side, the head rotates, and the eyeballs are rolled up. This gives way to the

Stage of Tonic and Clonic Convulsions. The movements, in the beginning confined to the head, extend to the neck, trunk, and extremities, rarely, however, passing to the legs. The neck is bent backward and fixed finally with the back in an opisthotonic curve. The arms are extended and rigid, the hands closed, with the thumbs in

the palms, and the knees flexed on the abdomen. The tonic convulsions involve the respiratory muscles, including the diaphragm. During the height of the paroxysm there may be one or two spasmodic respirations, although the chest muscles are strongly contracted. The tongue is partially protruded, and, being often bitten, the frothy saliva is tinged with red. Loss of sensation and consciousness is complete. Tonic convulsions last from ten to twenty seconds, and are succeeded by clonic spasms.

As in the early part of the attack, the clonic convulsions begin in the face, which is horribly distorted, and extend over the body. Respiration becomes irregular and noisy. The jaws open and close rapidly, and the tongue may again be bitten. As a rule, the body retains its previous position, but it may become necessary to hold the patient in bed. Toward the close of the attack respiration becomes full, labored, and stertorous. After one or two minutes the patient passes into the

Stage of Coma. This period lasts about half an hour. During its continuance consciousness and sensation slowly return. If recovery is to take place, the woman falls into a deep sleep, and wakes to ask confusedly what has happened. This unconsciousness has led mothers to deny their offspring born during eclampsia.

It is an exceptional occurrence for one attack only to occur. The first is usually followed at varying intervals by others. In case the seizures are uncontrollable and death is to ensue, the temperature rises progressively to 104° F. or more. The pulse is small, wiry, frequent, a semiconscious state supervenes, and death takes place during this period or in an attack from pulmonary œdema, cerebral congestion, hemorrhage, or exhaustion, or some days later from an intercurrent puerperal affection.

The Effect upon the Fœtus and Labor is almost constant. The former suffers decidedly—one attack may be sufficient to kill it. In twin pregnancy one or both may die. The child may survive several attacks. Winckel has observed a remarkable fact, that, if the fœtus is killed and pregnancy not at once interrupted, the onset and course of labor may be free from convulsions.

Pregnancy is apt to be terminated shortly, an accident easily understood in view of the shock, nervous disturbance, and uterine contractions. If the seizure occurs in labor, the pains are increased by the general muscular excitement, so much so that the child may be born before the physician is freed from his care of the mother.

The kidneys are involved in about two-thirds of the cases of eclampsia. In 84 per cent. the urine contains albumin in quantity varying up to 2.5 per cent. or more. Albuminuria, an important prodrome, increases with each attack, and decreases rapidly after their cessation. It usually contains sugar and formed elements, red and white corpuscles, and casts. In other words, symptoms of acute renal congestion are present.

Etiology. Theories of the causation of eclampsia have multiplied to such an extent within the past decade that an enumeration of them becomes confusing to the student, and we give here statements as to the little which is really known and the most reasonable speculative views, such as best agree with practical needs.

The prevailing tendency is to see in eclampsia a manifestation of the autotoxæmia of pregnancy. This toxic condition is able to give rise to

convulsions without the presence of structural lesions of the kidney, and is then known as cholemic eclampsia, because the liver in nearly all, if not quite all, cases of eclampsia is the seat of peculiar lesions and also because the symptoms suggest the highest degree of hepatic failure or insufficiency. Yet, in the great majority of cases, the underlying toxic state appears to produce lesions of the kidney, so that a vicious circle results, in which the renal alterations cause in their turn more or less interference with the renal functions. Hence, in addition to the basic autotoxic state, we encounter conditions which are hardly distinguishable from those of actual nephritis, viz.: oliguria, albuminuria (usually marked), formed elements in the urine (casts), œdema, retinitis, etc. Nothing is more certain, however, or more generally conceded than the dissimilarity of the blood state in eclampsia and true uræmia, and the latter cannot be regarded as the essential or perhaps even a contributory cause of eclampsia. When women with Bright's disease go through pregnancy, eclampsia very rarely develops. The so-called "kidney of pregnancy" is not a nephritis proper, but a temporary fatty infiltration; it usually undergoes complete regeneration after delivery. This, at least, is true of surviving cases in which prophylactic treatment has been instituted or which respond to curative measures. There is no doubt, on the other hand, that the basic autotoxic state may cause severe inflammatory lesions of the kidneys, for in fatal cases we find these organs almost destroyed. In such cases the toxæmia is so intense that death quickly results from cerebral poisoning and dissolution of the blood, the picture being identical with others in which the kidneys are intact. Uræmia is, therefore, not to be considered as a causal factor. Evidences of the dissimilarity of the two conditions has multiplied to such an extent that space is not available here to enumerate it. Thus, even in accurate suppression of urine—complete anuria—where true uræmia necessarily supervenes, the sensorium may be unclouded until death. Moreover, eclampsia is a febrile affection, and the temperature tends to rise with the progress of the convulsions; uræmia, on the other hand, is not a febrile condition, and the temperature may be subnormal. Dyspnœa, one of the most characteristic symptoms preceding uræmic convulsions, is usually absent in the pre-eclamptic state. Another point of difference is seen in the cryoscopic point of the blood in eclampsia and uræmia.

Despite the multiplicity of evidence that eclampsia is not uræmia, it must be confessed that the resemblance between the two conditions is marked in many ways. A small proportion of so-called eclampsia is doubtless uræmia pure and simple. Such cases are, of course, desperate from the start, for delivery cannot arrest the progress of the underlying nephritis.

As to the principal source of the poison in eclampsia, whether maternal, fetal, or placental, we have only theory at present. For a discussion of the speculations upon this theme the reader is referred to the rapidly increasing literature of the toxæmia of pregnancy. Whatever the source of the poison, we choose to regard the liver as the organ at fault, by reason of the great resemblance between the various degrees of pregnancy toxæmia and those of hepatic insufficiency in the non-pregnant—ranging from mere biliousness or hepatism up to acute yellow atrophy.

Aside from the essential cause of eclampsia, predisposing and exciting causes require mention. The writer regards the predisposition as chiefly that of the toxæmia of pregnancy itself. There should be, however, reasons for the tendency of eclampsia to appear, as a rule, late in pregnancy and to attack certain classes of gravidæ by preference. The reasons formerly adduced for the late supervention of eclampsia no longer hold good, and if we bear in mind that the most severe cases of acute toxæmia of pregnancy occur equally in the first half, we have to confess ignorance on this point. We are equally unable to explain why some 18.5 per cent. of cases occur after delivery, and why in 25 per cent. of cases labor is premature. In regard to classes of gravidæ attacked, we are unable to account for the great morbidity among primiparæ (nearly 80 per cent.) and for the fact that in about 8 per cent. of all cases twins are present. Finally, we cannot explain why convulsions cease after delivery in only 60 per cent. of cases.

Exciting causes are enumerated, but it is not easy to distinguish them from effects or coincidences. As in all convulsive affections, reflex excitability plays a marked rôle; so much so, in fact, that Dührssen and others recognize the existence of a purely reflex eclampsia which is mild in character and unattended by any evidences of toxæmia or renal disorder.

The Pathology of the condition is, as may readily be imagined, more than obscure. Post mortem the changes are an anæmia of the organs generally, a congestion of the cerebral cortex, occasional slight hepatic apoplexies, and a fluid condition of the blood. The chief changes, diminished urinary toxicity and corresponding increase in amounts of circulating poisons, are rather to be found *intra vitam* than after death.

Diagnosis of puerperal eclampsia, at first sight, appears to be simple, but to make a careless diagnosis is to invite a serious mistake sooner or later. The mere concurrence of a convulsive seizure with pregnancy or the puerperium does not *per se* warrant the conclusion that it is eclamptic. There are four conditions to which the pregnant parturient or the puerperal woman is subject which may be mistaken for eclampsia. They are (1) epilepsy, (2) hysteria, (3) apoplexy, and (4) meningitis.

Epilepsy is distinguished by the history of former and repeated attacks, by the presence of urine, normal in amount, free from albumin and casts (except in intercurrent nephritis), by coma more complete, by the absence of œdema and of prodromes, saving the usual aura. The epileptic falls suddenly with a sharp cry. *Hysterical* patients are conscious, as a rule, in the attack, the muscular contractions are less severe, there is never a coma. They scream, laugh, or cry, œdema is not present, and they pass large quantities of clear, pale urine. Here, also, a history of previous attacks may be elicited. *Apoplexy* is rare in pregnancy. It comes on suddenly without prodromata. Coma supervenes early. Convulsions are absent, and paralysis evident. *Meningitis* is even more rare. The history will aid materially in forming an opinion. The convulsions are local as opposed to general in eclampsia, and they increase in severity by easy stages. Fever always precedes their appearance.

In all cases of doubt careful attention should be paid to the urine, and

its quantity, the presence of albumin, sugar, blood, and casts, be thoroughly investigated. With these aids to the clinical picture, the attendant should have little difficulty in forming a correct opinion.

Prognosis. Puerperal eclampsia is a most serious affection. Even at the present day the maternal mortality is 30 per cent., that of the child 50 per cent. The pregnant woman who is suffering from decided symptoms of toxæmia, albuminuria, and the quantity of whose urine is daily diminishing, is in great danger of an attack. As the albumin increases and the quantity of water passed in the twenty-four hours diminishes, the danger becomes more imminent. The peril becomes more remote as the converse takes place. Urea, as to amount excreted, is a better guide in prognosis, as shown by Bouchard and Davis, than albumin. The latter found toxic symptoms to diminish with its increase. The earlier in pregnancy the seizure occurs the worse the prognosis. Schauta has proved time and again that all disturbances, even those of the kidneys, decline after the death of the child; consequently the sooner it dies in repeated attacks the better the prognosis. An early occurrence of profuse sweating is an encouraging sign. Prognosis is most unfavorable when the attacks occur in pregnancy, when they succeed each other rapidly, and become progressively more severe, and when they have lasted for some time before aid is secured. Chloroform treatment has lessened mortality in these cases. To sum up, prognosis is favorable when—

1. The attacks are infrequent and mild.
2. The child dies.
3. The patient is conscious in the intervals.
4. There is a small amount of albumin.
5. A fall of temperature occurs.
6. The attacks occur late in labor or during the puerperium.

Prognosis is unfavorable when opposite conditions prevail. The child born of an eclamptic mother has a diminished vitality, and often dies in the first twenty-four hours.

The *causes of death in the mother* are exhaustion, apoplexy from forcible rupture of the cerebral vessels, asphyxia due to spasm of the muscles of the glottis and of respiration, pulmonary and cerebral œdema, the result of serous effusion from distended capillaries, cerebral congestion, of which coma is a symptom, and paralysis of the heart. The last, when it occurs in the general spasm, causes instant death. The *causes of the child's death* are the mother's convulsions and the pressure exerted by them, asphyxia from compression or œdema of the placenta, or the excess of carbon dioxide in the blood, possibly direct poisoning by the toxic materials in the maternal circulation.

Treatment. Granted the contention, which, if not absolutely correct, is at least the best theory of etiology we have to-day, that eclampsia is the result of toxæmia, then of the two treatments of eclampsia, prophylactic and curative, the former is by all odds the more important, since the seizure is generally preventable. This is an opinion which is shared by many prominent American as well as foreign obstetricians.

(*a*) The Preventive Treatment. What symptom or sign, or what combination of symptoms or signs, is at our disposal for the

recognition of the pre-eclamptic state in time to prevent the subsequent eclamptic convulsions?

The symptoms of the state preceding an eclamptic attack include a rapid pulse, accompanied usually by high arterial tension, loss of appetite, gastric and intestinal disturbances, headache, lassitude mental and physical, a gradual or rapid diminution of all the excretions, both liquid and solid—in a word, what one would expect to observe from the introduction or retention in the blood of some toxic material.

Aside from the direct examination of the blood itself, the condition of the urinary secretion offers us the most convenient physical sign or clinical index of this pre-eclamptic state. The amount of urine passed in twenty-four hours is not always a reliable guide of kidney failure. Albuminuria, as is well known, may be absent before, during, and even after an eclamptic seizure. The amount of urea excreted is a far better guide, as has been shown by Bouchard, of Paris, in the non-pregnant condition, and recently by Dr. E. P. Davis, of Philadelphia, in pregnancy; for the latter found that when urea fell to 1.5 per cent. stimulation of the excreting processes resulted in distinctly favorable results in all cases in which toxic symptoms were previously present. It is not to be inferred from this that urea causes the convulsions, for large quantities of urea may be injected into rabbits without producing toxic symptoms. Indeed, Bouchard found that bile had nine times the toxic power of urea. It is generally accepted that the diminution in the amount of the urea excreted indicates kidney inadequacy; but it is not always a reliable guide. There are other substances in the urine with as great or greater poisonous qualities. Urea may be found in sufficient quantity and an eclamptic attack occur. Bouchard determined the toxicity of the urine by injections of the same into the circulation of rabbits. His experiments show that the normal healthy urine is toxic in the proportion of a certain unit per kilo by weight of the rabbit. In kidney insufficiency, when some poison or poisons are retained in the circulation, the toxic properties of the urine diminish, and it requires more of the urine to the kilo by weight of the rabbit to produce toxic symptoms in the animal. This gives us a delicate test for determining kidney inadequacy in doubtful cases. Bouchard's experiments further show that in renal insufficiency the poisons retained in the patient's blood arise from:

1. Food, especially nitrogenous food, as muscle, and food containing the salts of potassium.
2. Bile.
3. Putrefaction in the intestines, and absorption of its products.
4. Toxic materials constantly being produced by the metabolism of all the cells of the body.

To this last may be added the metabolism of the fœtal tissues, as this greatly increases the toxic material in the mother's blood, for, clinically, it is a familiar fact that when the fœtus dies *in utero*, or is delivered in the case of a living child, the eclamptic seizures usually cease.

Again, Winckel's observation, that in twin and triple pregnancies there is a greater predisposition to eclampsia, has been verified by others. Moreover, the tendency to eclampsia becomes greater proportionately

with the advance of gestation and the consequent increase of fœtal metabolism.

Further, we know that the maternal mortality diminishes progressively from the ante-partum to the post-partum states, namely, that it is greatest when eclampsia sets in during pregnancy, is less during labor, and lowest of all when the attack occurs for the first time after the birth of the child. Thus, the mortality during eight years at the Boston Lying-in Hospital, as has been shown by Green,[1] was: ante-partum eclampsia, maternal mortality, 46 per cent.; fœtal mortality, 69 per cent. Intra-partum eclampsia, maternal mortality, 25 per cent.; fœtal mortality, 25 per cent. Post-partum eclampsia, maternal mortality, 7 per cent.

Our present knowledge of the causation of puerperal eclampsia, meagre though it be, furnishes us, if not with the key to the successful preventive treatment of the condition, still with a working hypothesis, namely, the early recognition of the pre-eclamptic state. To accomplish this something more than a perfunctory monthly or bimonthly examination of the urine for the presence of albumin is called for, since non-albuminuric eclampsia occurs in from 9 to 16 per cent. of cases, and it would appear to be quite as fatal as an eclampsia accompanied by albuminuria, if not more so. Something more is demanded than the late recognition of renal insufficiency, as it shows itself in a marked diminution in the quantity of urine, specific gravity of the same, and amount of urea excreted.

When obstetricians shall accustom themselves to watch their cases of pregnancy, not only for the physical signs of pronounced renal inadequacy as an index of an approaching eclamptic attack, but also for the general symptoms of the overcharging of the blood with toxic material —as high arterial tension, headache, gastric disturbances, physical and mental lassitude—and further for failure of the bowels, liver, skin, and lungs properly to perform their functions, and intelligently treat the same, then, and then only, shall they have done their whole duty by their patient, and done all in their power to correct the pre-eclamptic condition and avert an impending eclampsia.

The writer's line of treatment of this pre-eclamptic state may be formulated somewhat in the following manner:

1. *Reduce the amount of nitrogenous food to a minimum.*

2. *Limit the production and absorption of toxic materials in the intestines and tissues of the body, and assist in their elimination by improving the action of* (1) *the bowels,* (2) *the kidneys,* (3) *the liver,* (4) *the skin, and* (5) *the lungs.*

3. *If necessary, remove the source of the fœtal metabolism and of peripheral irritation in the uterus by the emptying of that organ.*

The first indication—reduction of the amount of nitrogenous food to a minimum—can best be fulfilled in an exclusive milk diet, to which, as the symptoms subside or disappear, can be added fish and white meats. It is not only safer, but less trying to the patient, to commence with an absolute milk diet, than to compromise and afterward be compelled to cut off all but the milk. For the second indication—that of elimination —an abundant supply of pure air and water must be assured. This

[1] Green: "Puerperal Eclampsia; Experience of the Boston Lying-in Hospital in the Last Eight Years," American Journal of Obstetrics, 1893, xxviii. 18-44.

may be assisted by moderate exercise or light calisthenics, or massage, in certain instances. For the bowels, the writer advocates daily doses of colocynth and aloes at bedtime, followed by a saline in the morning. For the liver an occasional dose of calomel and soda at bedtime, followed in the morning by one of the stronger sulphur waters, as Rubinat, Villacabras, or Birmenstorf. Increased diuresis is secured by maximum doses of glonoin. The action of the skin is encouraged by encasing the body in wool or flannel underclothing, by massage, by the warm bath, hot bath, hot pack, or hot-air bath, according to the urgency of the case.

It is well in instances of eliminative insufficiency to give at bedtime twice weekly, or more frequently, if necessary, a tablet composed of calomel, digitalis, and squill, each one grain, and muriate of pilocarpine, one-twentieth of a grain. This is followed in the morning by a full dose of Villacabras water. A decided diaphoretic-diuretic action follows the administration of such a combination, with the additional prompt action upon the liver and intestines as well. So of the five eliminative processes, four are stimulated to more energetic action by its use.

The fact that jaborandi has been practically abandoned as a diaphoretic in the presence of an eclamptic attack is no good reason for prohibiting its use in this, the pre-eclamptic state, in the absence of pronounced cardiac disease, and the writer advocates its use for its diaphoretic and diuretic actions.

Finally, when exercise cannot be taken and an abundant supply of fresh air is wanting, oxygen inhalations will prove of service. Some preparation of iron will also be called for, as the tincture of the chloride, or Basham's mixture.

This, then, is the general hygienic and medicinal treatment of the pre-eclamptic state. No hard and fast rule can be laid down. Every case must be treated on its merits. In one a restricted diet and mild stimulation of the renal and intestinal functions is sufficient, and the patient may be allowed to be about, and even exercise in the open air, her skin being protected from sudden changes by being incased in wool or flannel. Other more pronounced cases of eliminative insufficiency must be kept absolutely quiet in bed upon an exclusive milk diet, and the stimulation of all the eliminative organs must be resorted to, to remove the symptoms of impending eclampsia.

But it must be kept ever before us that the hygienic and medicinal treatment is only of secondary importance to the milk diet, and that the latter is the foundation of the preventive treatment of puerperal eclampsia. Given a case in which, in spite of an exclusive milk diet and the vigorous stimulation of the five excretory outlets already mentioned, the symptoms and signs of the pre-eclamptic condition continue or at any time become urgent, the indication is to induce abortion or premature labor artificially.

It is difficult to undersand the position of those authorities (notably of the British school of midwifery) who advise against inducing labor in the presence of urgent symptoms of the pre-eclamptic state.

The arguments that by the methods usually in vogue induced labor increases reflex excitability and precipitates convulsions; that by the same methods, because of the time necessary to remove the barrier of the cer-

vix, the patient's fate is sealed before the delivery is effected; and, moreover, that the onset of labor increases the danger to the patient, are good ones and demand attention.

In answer, it may be said that methods of terminating the pregnancy recommended here need not increase reflex excitability, and, if perchance they do, the excitability is readily controlled for the time necessary to accomplish our ends; that the time necessary is, in most cases, very short; and, finally, that to-day the onset of labor and the termination of pregnancy may be practically brought about at one and the same time, and there is thus no prolonged or tedious labor to react unfavorably upon the patient.

The objection raised by Byers (International Congress of Obstetrics and Gynecology, Geneva, September, 1896) that induced labor, because of the necessary manipulation, increases the risk of sepsis, should not deter the modern obstetrician from performing the operation when he knows that he is surgically clean.

Charles, of the Liége Maternity, reported, at the International Congress of Obstetrics and Gynecology in 1896, in favor of induced labor when treatment fails or the symptoms become urgent in the pre-eclamptic state. His statistical table shows that every mother recovered and 75 per cent. of the children were saved.

The writer recommends a rapid manual dilation of the os in these cases, but only after the cervical canal is in a condition favorable for its safe performance. Moreover, he would insist upon a complete dilation of the os before delivery is undertaken.

(*b*) The Curative Treatment. In the presence of an eclamptic attack we face a desperate condition. The latest statistics from various parts of the world still place the maternal mortality at from 25 to 35 per cent. As long as the pathology of eclampsia remains obscure there can be no rational curative treatment of the condition. Experience does not permit of recommending any single treatment. Many subjects recover, no matter what the treatment, many die in spite of treatment, and others do well without any treatment at all. No single treatment can be advocated; each case must be managed according to the indications present. Not a single but a combined treatment promises best for saving the lives of mother and child in the event of an eclamptic seizure. For this combined treatment three indications are offered, as follows:

1. *Control the convulsions.*
2. *Empty the uterus under deep anæsthesia by some method that is rapid and that will cause as little injury to the patient as possible.*
3. *Eliminate the poison or poisons which we presume cause the convulsions.*

Although these indications are named in the order of their importance, still they may all be carried out at the same time. In another class of cases we fulfil the first and third, and wait for a suitable moment to carry out the second. The third indication—elimination—should really go hand-in-hand with the first two and be put into action at one and the same time with them.

Control the convulsions. The four medicinal means most certain and safe as anti-eclamptics are chloroform, morphine (hypodermatically), verat-

rum viride, and chloral hydrate, the latter alone or combined with sodium bromide.

The writer's preference is for chloroform, veratrum viride, and chloral, in the order named. Until three years ago he used morphine freely in eclampsia, but has since abandoned its use almost entirely, as it apparently prolongs the post-eclamptic stupor and increases the tendency to death during coma by interfering with the eliminative processes.

Chloroform is of all agents the most reliable for immediate control of the convulsive seizures.

Second only to chloroform in value is veratrum viride. Provided the pulse be strong as well as rapid, it is the most certain means at our command for temporarily, and even permanently, controlling the convulsions. When the pulse is weak morphine hypodermatically, chloroform by inhalation, and chloral by rectum, with stimulation, if necessary, may be substituted.

Veratrum viride reduces the pulse-rate, and convulsions are practically unknown with a pulse-rate of 60 or under; it reduces the temperature; it relaxes and renders more yielding the rigidity of the cervical rings; it causes prompt diaphoresis and diuresis, so that it aids not only in the fulfilment of our first indication, the control of the convulsions, but in the third, the elimination of an unknown poison as well.

From ten to twenty minims of the fluid extract of veratrum viride, given subcutaneously, should, as a rule, be the initial dose. Ten minims more may be given in the same manner every half-hour till the pulse remains below sixty to the minute. The patient should be kept in a recumbent position while under the influence of the veratrum. Tumultuous action of the heart is likely to supervene on assuming the erect position. Vomiting and collapse, should they ensue, are readily controlled by whiskey or by morphine.

The last resort for controlling the convulsions is the prompt evacuation of the uterus. It may be added, however, that cold applications, such as ice-bags to the back of the head and neck, have a decided effect in controlling and in warding off convulsive attacks.

Empty the uterus under deep anæsthesia by some method that is rapid and that will cause as little injury to the woman as possible. Those who follow the teachings of Charpentier, of France, and Winckel, of Germany—namely, that the uterus in eclampsia should be left alone except after full dilation of the os, as the irritation of inducing labor or artificially dilating a cervix precipitates convulsive attacks—will, doubtless, see many cases lost that could by prompt and intelligent measures be saved. It would appear from careful observation that the danger is practically over in some 90 per cent. of cases the moment the uterus is emptied, if accomplished early in the attack. Not that by this means the convulsions always cease, but they become less dangerous, and the case becomes one of post-partum eclampsia, in which the mortality, as we have stated, is only 7 per cent.

Although one can scarcely find an authority to-day who absolutely rejects local interference in the presence of ante-partum or intra-partum eclampsia, yet authorities differ widely as to the extent to which such interference shall be carried. Charpentier, in 1892, as the result of an ex-

haustive analysis of four hundred and fifty-four cases of eclampsia, and again in 1896, as the result of further observation, practically arrives at the same conclusion, namely:

1. That labor should be waited for and terminated naturally whenever possible.

2. That induced labor should be reserved for exceptional cases in which medical treatment has entirely failed.

3. That interference should be delayed until the cervix is dilated or dilatable, so as to avoid danger to the mother; that in eclampsia Cæsarean section, manual dilation of the cervix, and especially deep incisions of the cervix are absolutely unjustifiable.

On the other hand, it would appear from the literature of the last five years, and from the reports of the International Congress at Geneva, September, 1896, that the weight of medical opinion is in favor of emptying the uterus in as short a time as possible in instances of eclampsia, whether the attack occurs before or during labor, although there is a wide range of opinion as to the means to be employed. In the second stage of labor, after dilation has been secured, all authorities are agreed that the immediate emptying of the uterus is indicated and is to be performed promptly; the indication under such circumstances is readily carried out without additional danger to mother or child. In pregnancy and the first stage of labor the undilated cervix is the barrier to immediate delivery, and it is here that obstetricians differ so widely as to the best method of procedure. An expectant or palliative treatment means almost certain loss of the child, and something like one-third of the mothers are lost. On the other hand, the child is saved and the mother is practically safe, as far as the eclampsia is concerned, if the uterus is immediately emptied by appropriate surgical means.

During pregnancy and the early part of labor four procedures are offered for rapidly emptying the uterus, viz.:

1. Cæsarean section.

2. Mechanical dilation of the cervix (various methods).

3. Deep incisions which at once completely remove the barrier of the cervix.

4. Combined mechanical dilation and deep cervical incision.

The first method, Cæsarean section, for the relief of eclampsia still carries with it a high mortality (36.26 per cent., according to Charpentier's figures); moreover, there are many objections to its employment, as the uterine atony and hemorrhage, the irritation of the uterine and abdominal scars and of the curative peritonitis about the uterine sutures, all of which are to be avoided as exciting causes of subsequent eclamptic seizures.

The second method, the mechanical dilation of the cervix and the immediate extraction of the fœtus, appears to be the popular method of the day. Properly performed the method is safe and efficient. Before dilation is well advanced, however, from forty minutes to an hour and a half is necessary safely to carry it out, and certain conditions of the cervix, even in this time, refuse to yield to manual dilation or result in lacerations into the lower uterine segment.

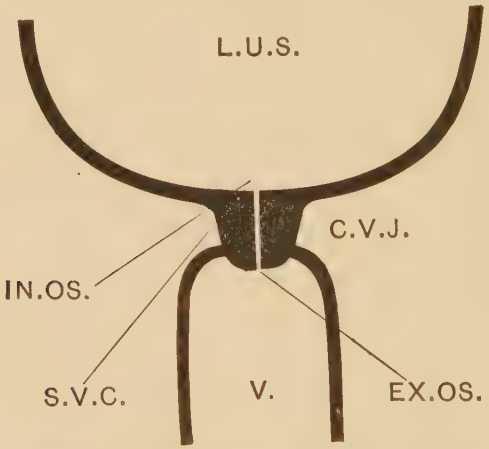
The third method of delivery, by deep cervical incision, offers a sur-

gical means for emptying the uterus in from five to ten minutes, provided the supravaginal portion of the cervix has disappeared or is made to disappear by appropriate means.

The fourth or combined method is a combination of the second and third methods, and is applicable to cases in which the supravaginal portion of the cervix is still present and rapid emptying of the uterus is demanded. Here mechanical dilation of the os until the internal os has been caused to disappear is made use of, and the dilation then in an instant completed by the incisions.

The third method and its modification, the fourth, are comparatively new, and we have few statistics as to the results of the operation. A rapid manual dilation of the os and subsequent extraction of the fœtus will fulfil the indications in most cases; but unless this can be intelligently carried out, with a due appreciation of the mechanism of dilation, especially in primiparæ, a purely expectant treatment will give better results. Unfortunately, puerperal eclampsia is four times more frequent in primiparæ than in multiparæ, although, on the other hand, the mortality is greater in the latter.

FIG. 379.



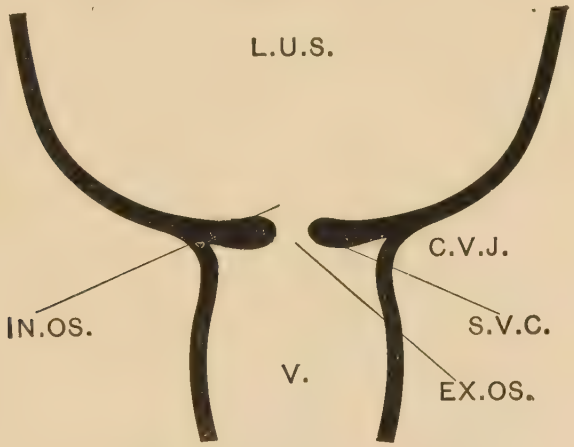
Cervix in latter part of gestation or at beginning of labor. Vaginal and supravaginal portions of cervix unchanged. (From EDGAR.)

V. Cuff of vagina. EX. OS. External os and infravaginal portion of the cervix. C.V.J. Cervico-vaginal junction. S.V.C. Supravaginal portion of cervix. IN. OS. Internal os. L. U. S. Lower uterine segment.

The cervix uteri is composed of constricting and dilating muscle, and, while it is true that the first convulsions usually induce labor, still the resulting asphyxia exerts a marked constricting action upon the body of the uterus and cervix, which is especially marked at the internal ring of the os. Therefore, any method of rapid manual dilation of the os that is undertaken before the internal os has been made, partially at least, to disappear is attended with great danger of uterine rupture (Figs. 379, 380). This is especially true in primiparæ, in whom the supravaginal portion of the cervix obtains late in pregnancy and even up to the begin-

ning of labor (Fig. 379). We believe a warning should be sounded against the careless undertaking of rapid manual dilations of the os,

FIG. 380.

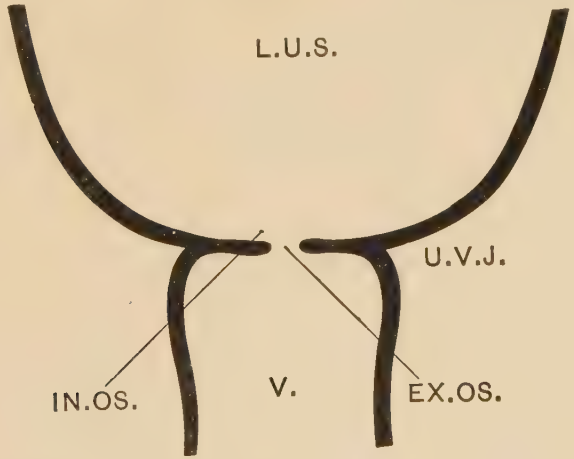


Lower uterine segment during labor. (From EDGAR.)

V. Cuff of vagina. EX. OS. External os, infravaginal portion of cervix has disappeared. C. V. J. Cervico-vaginal junction. S. V. C. Supravaginal cervix, small portion only remaining. IN. OS. Internal os. L. U. S. Lower uterine segment.

particularly in eclampsia. Uterine rupture and death have been the outcome. Moreover, undue shock has resulted from the dragging of a

FIG. 381.



Lower uterine segment during labor. Os uteri in progress of dilation. Supravaginal and infravaginal portions of the cervix have disappeared. Os admits one finger. (From EDGAR.)

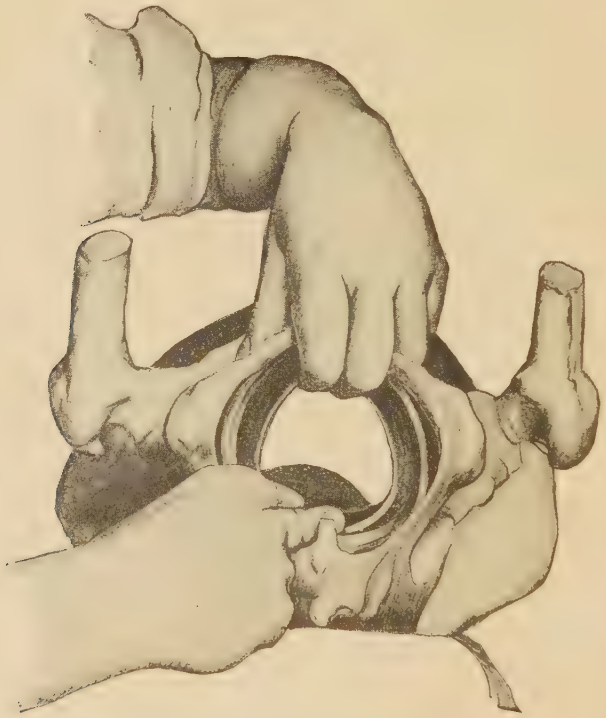
V. Cuff of vagina. EX. OS. External os. IN. OS. Internal os. U. V. J. Utero-vaginal junction. L. U. S. Lower uterine segment.

fœtus through an imperfectly dilated os, to say nothing of the loss of the child.

In placenta prævia the hemorrhage and the resulting anæmia of the

lower uterine segment and cervix render these parts more readily dilatable. In eclampsia the reverse obtains, as has been already hinted. Hence it is that in eclampsia in instances in which the internal ring of the os has been drawn up into the body of the uterus (Figs. 380, 381), and the external ring remains rigid and tense, particularly in primiparæ, and there is urgent need of rapidly terminating the labor, we prefer four clean incisions extending from the edge of the os to the utero-vaginal junction, in order to save the patient from the greater dangers of rapid manual dilation.

FIG. 382.



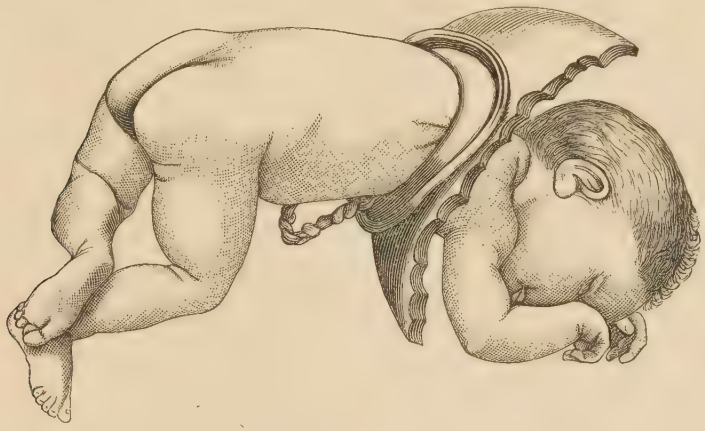
Bimanual dilation of the parturient os. (From EDGAR.)
Os two-thirds dilated. Entire effacement of the internal os. Compare Fig. 381.

In the second place, a warning is not out of place against the premature extraction of the fœtus before full dilation has been secured and the external ring of the os paralyzed. Premature extraction, under such circumstances, has, to the writer's knowledge, resulted in many unnecessary and dangerous lacerations of the lower uterine segment and an increase of the mortality for the child and mother.

Elimination of the poison or poisons which are presumed to cause the convulsions. To eliminate toxic materials from the blood and tissues the following measures may be relied on. It is essential, however, to rely not upon one but upon all the eliminative organs of the body, and that the fulfilment of this third indication in the treatment of eclampsia should go hand-in-hand with the two already mentioned.

To this end catharsis must be secured as early and as promptly as possible by the administration of croton oil, compound jalap powder, or calomel, followed by salines and high enemata of sulphate of magnesium. In the coma or post-eclamptic stupor of the condition the writer has relied mainly upon the repeated administration of concentrated solutions of sulphate of magnesium or Villacabras water, by means of a long rectal tube high up in the descending colon. The hypodermatic administration of magnesium sulphate has been found too slow and uncertain to be of any use. Diuresis is obtained by dry or wet cups over the kidneys, followed by hot fomentations. The value of glonoin as a diuretic and antieclamptic, the latter by reducing the arterial tension, cannot be overestimated. Second only in value to glonoin is veratrum viride. It is to be given at this time for the same reasons and for the same results as when it was administered in the pre-eclamptic condition. Diaphoresis is encouraged by means of the hot-air bath or the hot pack, the writer's preference being for the former. Pilocarpine as a diaphoretic in the

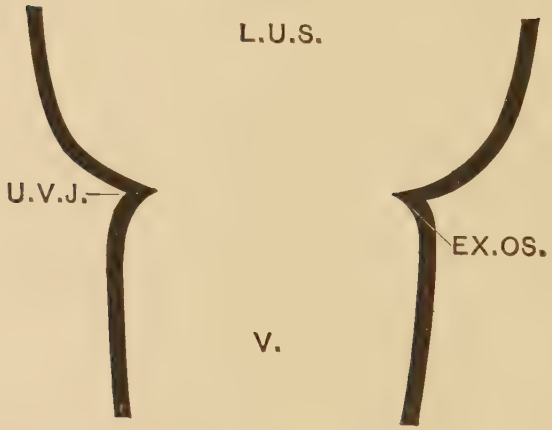
FIG. 383.



Dangers of a rapid breech extraction through an imperfectly dilated os. External os not fully dilated or paralyzed. Traction on the legs results in extension of the head and both arms. (From EDGAR.)

presence of an eclamptic attack should be utterly rejected, because of the danger of œdema of the lungs and glottis which it may produce. These conditions may follow promptly upon its administration. The drawing off of large quantities of toxic liquids in the form of blood or serum, by means of venesection, catharsis, diaphoresis, diuresis, followed by the replacement of the same by intravenous, stomachic, rectal, or hypodermatic means, causing a washing or disintoxication of the blood and tissues, as it were, has thus far proved of doubtful value. On the other hand, the prolonged irrigation of the lower bowel with either normal saline or sterile water, by means of a long single or return-flow tube, has given most excellent results. In instances of collapse, with the small compressible pulse, the introduction into the blood of a normal saline solution is of the same value here as in collapse under other circumstances. As a diuretic the frequent (hourly) subcutaneous injection of ether has been highly praised by some. As a general stimulant, to assist in the elimi-

FIG. 384.



Lower uterine segment at completion of first stage of labor. Os uteri completely dilated. (From EDGAR.)

V. Cuff of vagina. EX. SO. Border of external os, scarcely perceptible. U. V. J. Utero-vaginal junction. L. U. S. Lower uterine segment.

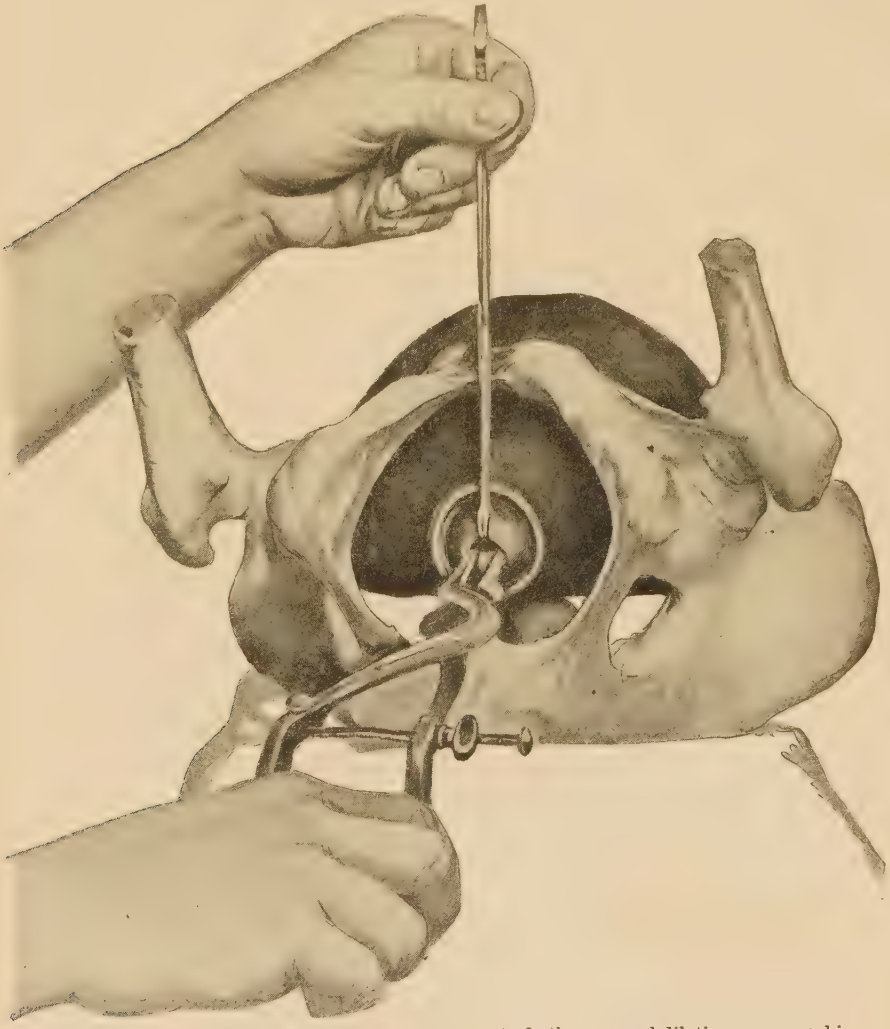
FIG. 385.

Bimanual dilation of the parturient os. (From EDGAR.)

Os is fully dilated and is being stretched and paralyzed, to prevent subsequent accidents to the after-coming head during the extraction of the fœtus. Compare Fig. 379.

nation from the lungs and to prolong life in the post-eclamptic stupor or coma, the free administration of oxygen is of the greatest value. Further, alcohol will often be needed as a stimulant during and after an eclamptic attack, and strychnine in the post-partum state and in the face of threatened collapse—although for physiological reasons it would seem to be contraindicated—has served us well.

FIG. 386.



Instrumental dilation of the parturient os, preparatory to further manual dilation, gauze packing, and the introduction of bougies or cervical dilators for the induction of labor. (From EDGAR.)

Finally, although no one has been or is a firmer believer than the writer in the efficacy of a prompt removal of fœtal metabolism and of irritation for not only the control but the cure of the eclamptic condition, still he begs to enter a protest, first, against the careless use of the term

accouchement forcé as applied to the rapid, scientific, and intelligent emptying of the uterus; and, secondly, to the easy confidence with which this *accouchement forcé* has been recommended as the best, if not the only, means at our command for the control of eclamptic seizures, without attaching sufficient importance to the condition of the cervical barrier. By *accouchement forcé* are understood to-day three operations, namely, (1) the complete instrumental or manual dilation of the cervical canal, followed by (2) either combined or direct version or the application of the forceps, and (3) the immediate extraction of the child.

FIG. 387.

Digital dilation of the parturient os. (From EDGAR.)

Os admits one finger. Vaginal and supravaginal portions of the cervix present. Compare Fig. 379.

The *accouchement forcé* of the older writers upon obstetrics was often quite another and more serious operation, for the condition of the cervical canal was frequently lost sight of, and it too often meant (1) the plunging of the hand or the application of the forceps through a cervical canal imperfectly dilated, and (2) the immediate extraction of the fœtus through this constricted os. That the latter definition of the

term still obtains seems proven by the frequency of accidents in the extraction of the fœtus that are constantly being brought to light.

Our maternity hospitals are repeatedly in receipt of ambulance or emergency cases due to the neglect on the part of the operator to fulfil the first condition of the operation, namely, complete dilation. It is no uncommon event for emergency cases to be brought to our hospitals

FIG. 388.

Bimanual dilation of the parturient os. (From EDGAR.)

Os admits two fingers. Vaginal and supravaginal portions of the cervix present. Commencing shortening of the cervical canal. Compare Fig. 379.

with a podalic version or extraction partially completed because of the operation being attempted in the presence of a partially dilated os (Figs. 382, 383); moreover, for uterine rupture to occur, due to the same cause.

In Fig. 383 is represented the outcome of a premature extraction through an imperfectly dilated os. With such a complication—a rigid,

imperfectly dilated external os, grasping the fœtus tightly under the armpits—the loosening of the arms, the dragging of these, and subsequently the head through the os will take considerable time, and not only forfeit the child's life but subject the lower uterine segment to dangerous, if not fatal, rupture. Our plea in these cases is not alone for complete dilation or disappearance of the external ring, as seen in Fig. 384, but further, for a paralysis of the ring, as we see it performed in Fig. 385,

FIG. 389.

Bimannal dilation of the parturient os. (From EDGAR.)
Os admits three fingers. Supravaginal portion of the cervix disappearing.

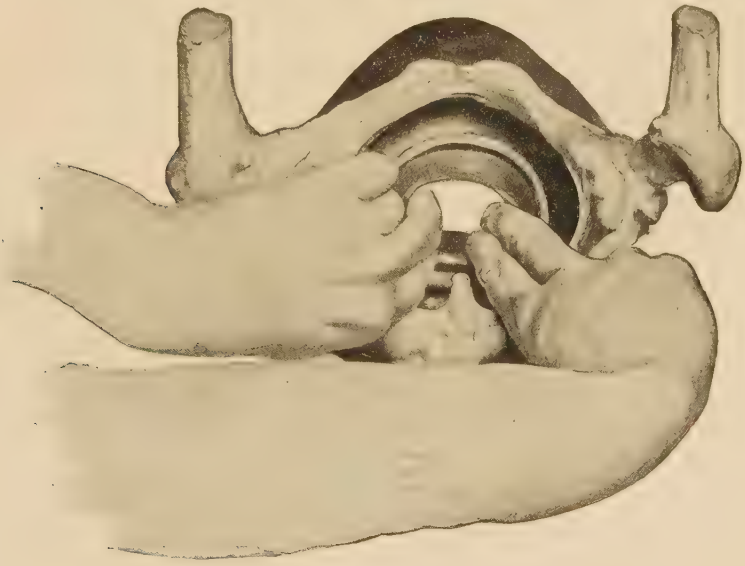
so that the dangers of the extraction, whether by forceps or version, may be reduced to a minimum for both mother and child.

The limits of the present article forbid entering upon the arguments for or against any particular variety of rapid manual or instrumental dilation of the parturient os, further than to state that the writer's pref-

erence is for a rapid bimanual method, as shown in the illustrations, since he has given this method an abundant trial over a period of several years, and it has proved most satisfactory.

The bimanual method is to be preferred to other digital and instrumental methods, because (1) the membranes are preserved throughout the operation or until full dilation is obtained; (2) there is no interference with the original presentation and position; (3) the sense of touch of the operator's fingers is unimpaired; (4) there is no constriction of the operator's hands; (5) the amount of force exerted upon the external ring can be better estimated, and hence there is less likelihood of lacerations occurring; (6) in placenta prævia there is less preliminary separation of the placenta by this method than by any other; (7) by no other method with which we are acquainted can not only complete dilation, but also

FIG. 390.



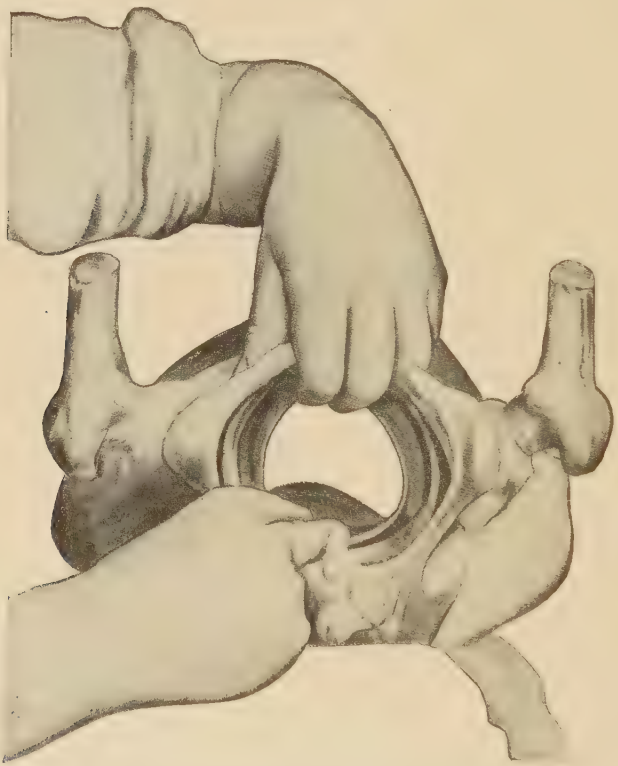
Bimanual dilation of the parturient os. (From EDGAR.)
Os one-half dilated. Lateral position of the hands.

complete paralysis of the parturient os, be so quickly and safely obtained (Figs. 382, 385).

Again, the writer begs leave to protest against the undertaking of a rapid manual dilation of the os (namely, the entire dilation completed within an hour) before the cervix has become, at least slightly, relaxed by uterine action, and is already somewhat yielding. A rigid cervix, in the condition seen in Fig. 379, should receive preliminary treatment, by means of a cervical dilator of gauze or a hydrostatic bag, that will set up some uterine action and render the rings of the os yielding enough to make rapid dilation a safe operation. In the presence of even a minimum amount of uterine action, or with a softening, yielding, and relaxing os, although the anatomical conditions shown by Fig. 379

may obtain, one may still undertake rapid manual dilation and produce complete paralysis of the cervix within an hour, as seen in Fig. 385. Far better a purely expectant treatment, as regards emptying the uterus, than the attempt rapidly to overcome a rigid os by manual methods, the supravaginal portion of the cervix being present. The writer has known complete uterine rupture to result from such an undertaking, the maternal intestines prolapsing between the fingers of the operator. Fortunately for the eclamptic woman, the frequency of the attack increases proportionately with the progress of gestation, and, it may be added, with the increase of fœtal metabolsim. Hence, the attack is more

FIG. 391.



Bimanual dilation of the parturient os. (From EDGAR.)
Os two-thirds dilated. Entire effacement of the internal os. Compare Fig. 381.

frequent in the latter part of pregnancy and in labor, when we can more readily and safely apply our surgical principle of treatment, namely, an early and rapid evacuation of the uterus.

Unfortunately, the attack is four times more frequent in primiparæ than in multiparæ, and in the former the presence of the supravaginal portion of the cervix late in pregnancy, and of an unyielding and unrelaxed os, compels us to make use of preliminary and temporizing means before we can safely perform a rapid dilation of the os and subsequent extraction of the fœtus. It is in such cases, and at such a critical time,

when one is waiting for the measures preparatory to a rapid dilation and emptying of the uterus to act, and to give us at least a yielding and relaxed cervical canal, if not a partial disappearance of the internal os, that the writer has found veratrum viride most valuable and life-saving, by reason of the various actions of the drug already mentioned.

In order to render the preferred method of rapid dilation of the pregnant or parturient os more graphic, and also that the sequence of the

FIG. 392.

Bimanual dilation of the parturient os. (From EDGAR.)

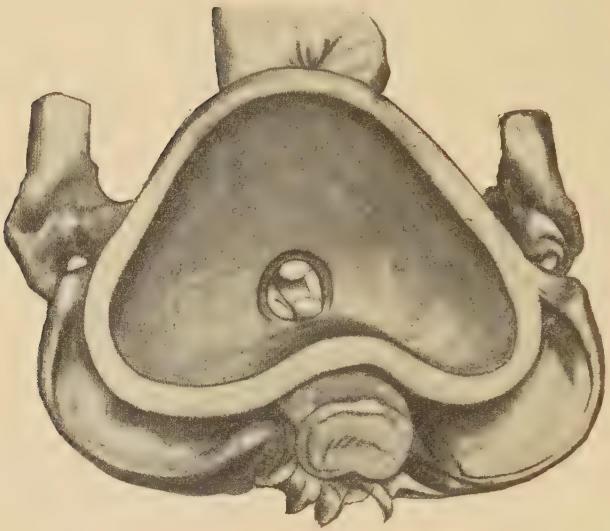
Os is fully dilated and is being stretched and paralyzed to prevent subsequent accidents to the after-coming head during the extraction of the fœtus. Compare Fig. 384.

different steps of the operation may more clearly be set forth than they are in the limited number of illustrations in the article upon puerperal eclampsia, the nine illustrations[1] (Figs. 386–394) are introduced.

The illustrations demonstrate the different steps in a rapid dilation of the os uteri, commencing with instrumental dilation (Fig. 386) at

[1] These illustrations are from photographs of composition and plaster models, and have already appeared in a series of articles on "Methods and Aids in Obstetric Teaching," published in the New York Medical Journal, November 14, 21, 28, and December 5, 1896.

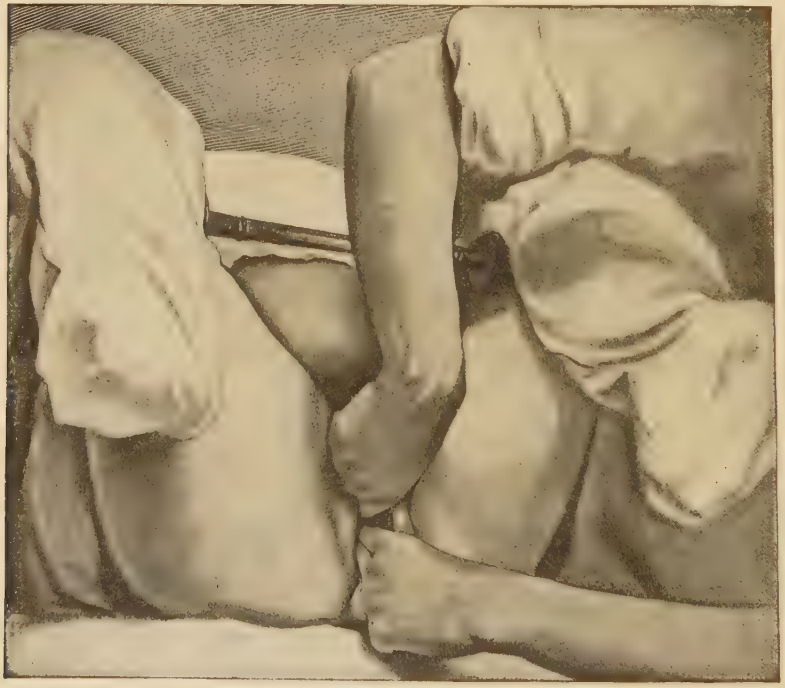
FIG. 393.



Bimanual dilation of the parturient os. (From EDGAR.)

Internal view, showing the position of the fingers. Os admits three fingers readily. Internal os still present. No encroachment of the fingers upon the cavity of the lower uterine segment. Compare Fig. 394.

FIG. 394.



Bimanual dilation of the parturient os. (From EDGAR.)

External view, after a photograph of the operation as performed at the Emergency Hospital, New York.

a time when the internal os has partially disappeared, and the cervical canal is somewhat relaxed and yielding, continuing with digital dilation, and finally ending with bimanual stretching and paralyzing of the fully dilated parturient os uteri (Fig. 392). In Fig. 393 is shown the position of the fingers in the bimanual method of cervical dilation, as seen from the uterine cavity; and Fig. 394 is added, which is after an actual photograph of the operation of manual dilation of the parturient os, taken from nature at the Emergency Hospital (Bellevue Hospital service), in order that the position of the patient and the position of the operator's hands during the operation may be clearly seen.

CHAPTER XXIV.

DIABETES.

Diabetes mellitus is a dangerous complication of labor and the puerperal state, as it is well known to be of surgical operations. Fortunately, it is rarely met with in obstetric practice. The disease may antedate the pregnancy or may develop in the course of it. That it may occur as a result of pregnancy would seem possible from the fact that in exceptional instances the disorder appears only during gestation, subsiding after delivery. It may be present in one or more and absent in subsequent pregnancies. A transient glycosuria is met with in a small percentage of pregnant women, but is most frequently a lactosuria. Lanz administered chemically pure grape-sugar to several women immediately after labor in quantities of 100 grammes to each. The urine was drawn by catheter just before the ingestion of the sugar and at the end of two, four, and six hours subsequently. In 30 per cent. of the urines grape-sugar was found. These observations go to prove that sugar metabolism is diminished in the first few hours or days of the puerperium and probably in the later weeks of pregnancy.

Frequency. There are no sufficient data on which to base a definite statement of the frequency of diabetes as a complication of labor. Statistics show, however, that the disease is associated with pregnancy in less than 1 per cent. of diabetic women.

Diagnosis. The essential phenomena of the disease are the same in pregnant as in other patients. The diagnostic evidence is to be sought chiefly in the urine. The test of sugar should be included in the usual urinary examinations during pregnancy, yet lactosuria must not be mistaken as evidence of diabetes. Lactose is present in the urine during the later weeks of gestation in about 4 per cent. in healthy women, and more frequently in the first few days after labor. The liquor amnii is usually excessive in amount, and it contains sugar and sometimes acetone.

Prognosis. Pregnancy in women previously diabetic terminates in abortion in about 33 per cent. of cases. The prognosis for the mother is especially grave when the disease is aggravated by pregnancy and resists treatment. The danger to life is greatest in the later months; 50 per cent. of the mothers suffering from this disease die soon after labor. Of 22 cases collected by Matthews Duncan, 4 were fatal after delivery, within the puerperal period, death being due to collapse and coma. The mortality for the children born of diabetic women exceeds 40 per cent. It very frequently happens that the fœtus dies soon after the period of viability. Sometimes the child is dropsical; it may be diabetic. In view of these facts a woman the subject of diabetes should not become pregnant.

Treatment. The medicinal and dietetic treatment of diabetes in the

pregnant patient does not differ from that usually adopted under other circumstances. If the symptoms are pronounced, and especially if they are not relieved by treatment, the pregnancy should be terminated.

Cardiac Disease.

The physiological hypertrophy of the heart in pregnant women, the occurrence of which has recently been reaffirmed, testifies to the increased work put upon it during gestation. Pre-existing cardiac lesions are liable to be aggravated by pregnancy, and in advanced disease the heart may seriously be crippled in the later months. The circulatory disturbance usually begins near midpregnancy. The danger is especially great under the added strain of labor, and it culminates in the third stage, when a large volume of blood is abruptly thrown upon the venous side by the uterine retraction, causing dilation of the right heart. Yet in a considerable proportion of cases the heart, even though damaged, proves equal to the increased demand upon it, and apparently sustains little or no added injury.

The mitral valve, either alone or with others, is oftenest affected. Of 92 cases of valvular disease in pregnancy collected by Porak, the mitral valve alone was diseased in 57; both mitral and aortic valves were involved in 22. In 22 there was mitral insufficiency, in 13 mitral stenosis, and in 22 both conditions were present; in 13 the aortic valve only was diseased, insufficiency existing in 9, stenosis in 2, and the double lesion being present in 2.

Prognosis. Most fatal of the valvular lesions in pregnancy is mitral stenosis; 8 of the 13 cases recorded by Porak terminated fatally. McDonald reports 14 cases with 9 deaths. In double mitral lesions the mortality is still greater. The death-rate in aortic disease is from 23 to 25 per cent., while in mitral insufficiency, the best borne of all the valvular affections, the proportion of deaths is not far from 13 per cent.

Endocarditis is a grave complication of labor and myocarditis is still more so.

A period of great danger is the close of the second stage of labor. During the pains of this stage the venous circulation is impeded by the prolonged and violent expulsive efforts. The right heart is dilated, as indicated by the swollen veins of the neck and the cyanotic hue of the face. At the moment of expulsion or directly after, as the uterine sinuses are emptied, an additional volume of blood is thrown upon the already overloaded right heart.

Even greater peril attends the close of the third stage, when the engorgement of the venous circulation becomes still more pronounced.

Obviously the prognosis must depend largely on the condition of the myocardium. With full compensation the patient may pass safely through pregnancy and labor. In advanced cardiac disease the prognosis is always bad. In marked failure of compensation, with dilation of the right heart and much pulmonary congestion or œdema and albuminuria, it is extremely grave. Owing to the increased labor imposed upon the heart in the later months of pregnancy, existing cardiac disease is, as a rule, permanently aggravated by child-bearing.

All forms of heart disease predispose to abortion. In a certain proportion of cases the pregnancy terminates prematurely. The immediate cause of the abortion may be excess of carbon dioxide in the blood or placental apoplexies.

The tendency to post-partum hemorrhage is increased by the circulatory obstruction, yet moderate bleeding at the close of labor is conservative by relieving the venous engorgement.

Symptoms. The symptoms of valvular disease vary according to the extent of the lesion, the valves affected, and the amount of compensatory hypertrophy which is present. They do not differ essentially from the usual manifestations of similar lesions under other circumstances. Palpitation, dyspnœa, and more or less præcordial distress are common in the later months of pregnancy, even in the milder forms of valvular disease.

Dilation of the right heart is attended with visible pulsation of the veins of the neck and with epigastric pulsation. The first sound is weak and the area of dulness is increased. Pulmonary congestion or œdema and venous stasis in other viscera frequently develop, especially during labor.

Treatment. Peter says a woman with heart disease should not marry; if she is married she should not become pregnant; if she has passed through one or two pregnancies safely she should not again become pregnant; and, finally, if she gives birth to a child, she should not be allowed to nurse it. Peter's dictum, however, is too sweeping. It should be limited rather to the grave forms of valvular defect and to incompetence of the heart-muscle.

The hygienic management of cardiac disease in pregnancy is important, and consists in the avoidance of undue exertion, physical or mental, of sudden chilling of the surface of the body, and in the removal, if possible, of all sources of nervous disturbance.

The medicinal treatment either during pregnancy or labor is for the most part symptomatic. Iron, arsenic, or strychnine are frequently indicated as tonic measures. For cardiac supports, strophanthus in 5-minim doses of the tincture several times daily, or the tincture of digitalis, 5 to 10 minims three times daily, may sometimes be given with good effect.

The obstetric management of serious cardiac disease will often tax the physician's skill and judgment. When the woman is in imminent peril the artificial interruption of pregnancy is demanded. Yet, when the conditions are bad enough to justify interference, even a premature labor is attended with great danger. Kaltenback regards uncompensated valvular disease as a positive indication for the induction of labor. Fehling would terminate the pregnancy when, in addition to the non-compensation, there is chronic bronchitis with marked emphysema. In the presence of such pulmonary congestion and œdema, with extensive visceral complications, general anasarca or ascites, and extreme dyspnœa, and especially if the symptoms become more pronounced notwithstanding treatment, the uterus should be emptied. Winckel, on the other hand, speaks discouragingly of the results of premature delivery.

The indications after labor has begun are to deliver the patient with as little exertion on her part as possible. Chlororoform should be used

to diminish violent effort and to limit shock. After sufficient relaxation forceps should be employed. Should the dilation be slow, it may be hastened by artificial means; manual dilation or, if the emergency requires, Dührssen's incisions should be practiced. Sudden asystole at the end of the second or third stage is best met by inhalation of from 3 to 6 minims of nitrite of amyl. The action of trinitrin, given hypodermically, is similar in character, but is not nearly so prompt as that of nitrite of amyl by inhalation. When these measures fail, from 10 to 16 ounces of blood may be taken from the arm. Ergot should be proscribed, since it contracts the arterioles and increases the circulatory obstruction; moreover, it limits the blood loss from the uterus. Moderate bleeding after delivery is beneficial. When not sufficiently free it should be favored by the use of douches of warm sterile water, at a temperature not exceeding 40° C. (104° F.). If during the labor the patient suddenly expires, the child being viable, accouchement forcé or, if need be, Cæsarean section should at once be performed, in the hope of saving the child.

PART VII.

PATHOLOGY OF THE PUERPERIUM.

CHAPTER XXV.

ANOMALIES AND DISEASES OF THE BREASTS AND NIPPLES.

Normal Data. The reader will recall that each mamma empties its secretion through the nipple by means of about twenty ducts in direct communication with the mammary acini. These ducts are lined with cuboidal epithelium.

The acini are composed of saccular dilatations of the terminal ends of the smallest ducts, and possess a membrana propria lined with characteristic secretory epithelium. White, fibrous and adipose tissues surround the acini in varying proportions, according to age and the individual. Like all other active glands, the mammæ are rich in bloodvessels, lymphatics, and nerves.

The blood-supply is peculiar in that the ducts are surrounded by a vascular plexus, instead of parallel vessels inosculating with one another as in the voluntary muscles.

The nerve-endings have never been conclusively traced; but they doubtless terminate in the parenchymatous elements.

The lymphatics communicate ultimately with a single large channel extending to the axilla.

The breasts reach fullest development during pregnancy, when the glandular epithelia become enlarged and filled with milk globules.

Anomalies.

Supernumerary nipples and breasts, defective development of the nipples, and absence of one or both breasts are met occasionally. Complete absence of the gland is rare, but imperfect development is common. There are but few cases reported of hypertrophy of the breast. It is said that lactation has been known to reduce an abnormally enlarged breast. Polymastia (supernumerary breasts or nipples) is common. The location varies, but is usually below the true breast. There may be one or more supernumerary breasts or nipples, which have been recorded as being situated either in the shoulders, umbilicus, back, groin, labium, or buttock. One case was reported as having nine breasts; another, ten nipples. These anomalies are of obstetric interest only in so far as they may affect the woman's ability to nurse her child.

Defects of the nipples are especially important, as they may interfere with nursing. Both congenital and acquired deformities are common.

The nipples may be primarily small, sunken, or inverted, or imperfectly developed from pressure of faulty clothing.

The nipple lesions of lactation are largely the result of defective development, and consequent difficulty in nursing.

Sore Nipples.

Nipple lesions of greater or less severity occur in nearly 50 per cent. of nursing women, and begin usually within the first few days after suckling is inaugurated, being due to maceration and abrasion of the cuticle by the infant. They are of clinical importance by virtue not only of the exquisite suffering they may occasion during nursing, but especially of their etiological relation to mastitis. Mere erosions may soon heal and give rise to no further trouble. While they persist they are often extremely painful, and they commonly lead to more serious lesions.

Fissures occur at the base or top of the nipple. The latter run transversely to the axis of the breast. Ulcers not infrequently result, and when milk-ducts open into the base of an ulcer they are occluded as the ulcer heals.

Etiology. Defective development and deformities, by rendering nursing difficult, frequently act to increase the injuries inflicted on the nipples during suckling. Needless maceration of the nipples by too prolonged and frequent nursing is often the cause of erosion and fissure. Soor or aphthæ (thrush, sprue) in the child's mouth exposes the nipples to infection. Uncleanliness of the nipples in the later weeks of pregnancy, and especially during lactation, is a common source of septic invasion.

Treatment. PROPHYLACTIC. Prevention should begin in the management of pregnancy. The presence of defective nipples should not escape the antepartal examinations. Teach the woman to draw them out daily during the last two or three months of pregnancy with clean fingers or by means of a suitable breast-pump. This practice not only tends to develop the nipples, but also prepares them to withstand better the mechanical violence of beginning nursing. The mother should be warned of the injury that may be done by tight clothing.

For at least a month before labor special attention must be paid to the cleanliness of the parts. Daily bathing in warm water and a bland soap, or with a solution of borax—a tablespoonful to the pint of boiled water—is a valuable precaution. The use of agents for hardening the nipples is not advised. There is reason to doubt that bathing the nipples with alcoholic and other astringent solutions is a suitable preparation for nursing. It is more than probable that hardening the skin predisposes it to cracking. It would seem more rational to keep the nipples as supple as possible. The application of fresh cacao butter or some equally bland emollient, as lanolin, after the daily cleansing promotes this end.

Dr. J. M. Mabbott praises the following treatment: Daily for a month or more before labor the patient anoints the nipples at night with lanolin, working it thoroughly into them by kneading them between the thumb and fingers. In the morning the nipples receive a prolonged scrubbing with a soft nail-brush and pure soap and water, care being taken not to abrade the skin surfaces. The nipples are then rinsed and dried.

When nursing begins the delicate cuticle of the mammilla may be broken

and abraded, and during the post-partal month the septic exposure is especially increased by the contact of hands liable to be infected from the lochial discharges. The occurrence of thrush or of ophthalmia in the child obviously adds to the risk of infection. Hence the need of a cleanly management of the nipples during the first weeks of lactation. The avoidance of septic contact is clearly important. Bathing with a boric-acid lotion before and after each nursing is specially advised. A saturated aqueous solution is not too strong. Cleansing the infant's mouth with a similar wash before and after each nursing is in the interest of both mother and child. Care must be taken not to abrade the buccal mucous membrane, lest the practice invite the trouble which it aims to prevent.[1] More active antiseptics are more effectual, but they require greater care in use. The writer has employed with satisfaction a nipple dressing wet with a mercuric iodide or chloride solution, 1–10,000 or 1–5000; the mercurial must be rinsed off with boiled water or with the boric-acid solution before nursing.

To limit the injury done by maceration and bruising, a single nursing need not occupy more than ten or, at the most, twenty minutes, and regularity should be insisted upon. See that both breasts are nursed, each on an average from seven to ten minutes.

The cacao-butter or some other similar inunction may be employed with advantage after each nursing, the surfaces having first been cleansed as already detailed.

Curative Treatment. Excoriations and slight fissures heal in most cases under proper and timely antiseptic treatment. An ointment of equal parts of subnitrate of bismuth and castor oil may be used as advised by Hirst. The writer has generally preferred to this a similar ointment made with the glycerite of starch. But the glycerin preparation may not always be well borne by the skin. The ointment should frequently be sterilized by heat. Before applying, the parts are disinfected. A valuable agent for the latter purpose is the hydrogen dioxide. While a host of nipple lotions and other applications have been recommended in these affections, none is more rational or promises better results in ordinary cases than some simple but carefully executed antiseptic plan of treatment.

Pain during nursing may be relieved to some extent by pencilling the nipple five or ten minutes before the child is put to the breast with a 1 to 5 per cent. cocaine solution. The solution should be heated to the sterilizing point shortly before using.

A 1 or 2 per cent. carbolic lotion applied in the same manner is sometimes useful as an anæsthetic. The addition of one-tenth its volume of glycerin prolongs the action of the lotion and keeps the skin soft.

After the application of drugs the nipples should always be cleansed before nursing.

In excoriations and fissures that are not too sensitive and do not bleed readily, nursing through a nipple-shield may be tried. The shield protects the nipple from the friction, and to some extent from the maceration of suckling. Unfortunately for this method, the child may not accept

[1] An easy and reliable method is to wrap a small piece of absorbent cotton or soft cheesecloth around one of the fingers, and, after saturating it with the boric-acid wash, to rinse out the child's mouth carefully. This allows all surfaces of the mouth to be bathed.

the substitute for the natural nipple. If artificial nipples are used, it is important that they be rendered aseptic by boiling for five minutes in water immediately before using and not handled with unclean fingers.

Similar protection to the nipple lesions is afforded, though in a less degree, by coating the affected surfaces with a pellicle of compound tincture of benzoin.

Deep and painful fissures may be treated with the solid stick of nitrate of silver. The entire raw surface should be touched. The lips of the fissure being well separated, the caustic point is drawn slowly through it. This is repeated, if required, in three or four days. Care must be taken that no excess of moisture is present, otherwise the dissolved silver salt may trickle over the surrounding surfaces and healthy structures be injured. A serious objection to this treatment is the exquisite pain it causes. This may in great measure be prevented by first benumbing the part with a 4 per cent. cocaine solution. After the application of the caustic the nipple may be covered with a piece of lint well wet with the anæsthetic lotion.

Instead of the solid stick, two or three applications daily of an aqueous solution of the nitrate of silver may be preferred. In the strength of 1 or 2 per cent. it causes little pain and frequently does good service. The affected nipple should be rested, if possible, for twenty-four hours or more.

When other measures fail, suspension of nursing for one or two days sometimes succeeds. If both breasts are affected each may be rested on alternate days.

It is very rarely that the nipple lesions are so rebellious to well-directed treatment as to necessitate the total abandonment of nursing.

Mastitis.

Mastitis occurs in 5 to 6 per cent. of nursing women, oftenest in primiparæ, and may or may not terminate in suppuration. In the great majority of cases it begins within the post-partum month.

Etiology. That the essential factor in mastitis is sepsis does not admit of discussion. Here, as elsewhere, the suppuration and the local morbid process which leads up to it are due to infection. Obviously the offending organism may be any of the pus-producing germs. Most frequently found, according to Escherich, are the staphylococcus aureus and albus. The streptococcus of pus is next in order of frequency. The lochia is a prolific source of infectious material, which during childbed is added to the usual septic exposures.

The predisposing causes and the methods of infection are questions involved in some dispute. Impaired general health and local mechanical injuries, diminishing the resisting power, are obviously important predisposing factors in many cases. Contusions of the breast from blows or from bruising with the breast-pump may become the starting-point of mastitis.

The influence of milk stasis, which is so large a factor in the popular belief, is differently estimated by obstetric writers. Olshausen denies that it causes inflammation. Roser holds that milk retention is a result, not a cause, some of the lactiferous ducts being occluded by inflammatory

swelling of surrounding structures. Others think milk stasis may favor the growth of bacterial organisms. Possibly retention by damaging the delicate endothelium of the lacteal ducts in the engorged areas may become a factor in the septic invasion. Engorgement alone is not a competent cause.

That the nipple lesions so common during early lactation hold a prominent place among the predisposing causes of infection does not admit of doubt. Fissures of the nipple and even the abrasions, which are almost invariably produced by the friction of the child's tongue and lips in the first weeks of lactation, expose the lymphatics directly to the entrance of septic organisms.

That the morbific agent in a considerable proportion of cases enters by the lactiferous tubules is beyond question. It is well known that pathogenic germs may penetrate healthy mucous or serous surfaces. Frequently the way is made easy by the injury done by milk engorgement or by mechanical violence. That pyogenic bacteria which have gained access to the milk ducts from without may pass into the deep structures of the gland, even against the milk stream, cannot be doubted. Recent observations have shown that staphylococci are frequently present in the milk of perfectly normal breasts. Palleski examined the milk of twenty-two healthy nursing women and found staphylococcus albus in ten. Similar observations have been made by other investigators. Honigman and Ringel contend that human milk normally contains the staphylococcus pyogenes albus and aureus. That mastitis occurs so infrequently, despite the frequent presence of the microbic causes of suppuration, must be explained by the fact that a favorable condition of the soil as well as the presence of the germ is necessary to bacterial growth.

A possible source of mammary inflammation which is not often mentioned by obstetric writers is infection through the blood channels. Karlinski declares that micro-organisms from the cavity of the uterus in process of involution may be found in the blood. Escherich affirms that staphylococci which have gained access to the blood through infection of the genital apparatus are excreted in the milk as well as by other channels. In the milk of infected puerperæ he found, without exception, staphylococcus aureus or albus. That infection of injured mammary tissues is possible from sepsis in remote organs is abundantly established by clinical observations and by the experiments of numerous observers on the localization of septic processes. Not alone direct injuries of the breast invite such localization, but there is reason to believe that general pathological conditions, even exposure to cold, may act in this manner.

We must conclude that the infecting organisms may reach the gland structures through the lacteal ducts, the lymphatics, or the bloodvessels; that nipple lesions, milk stasis, contusions of the breast, impaired general health, probably chilling, and genital or other remote infections are among the predisposing causes.

Symptoms. The essential symptoms of mastitis are pain, swelling, and localized tenderness in the breast, together with more or less rise of temperature. The attack is frequently ushered in by a chill or slight chilliness.

When pus forms fluctuation may usually be detected, and a deep red

or bluish discoloration of the skin is observed at the place where the pus comes nearest the surface. Yet fluctuation may be absent in deep-seated suppuration, and the evidence usually afforded by the appearance of the skin may be wanting, at least for a time, after pus is present.

Forms. There are three principal forms of mastitis: Glandular, subglandular, subcutaneous. To the latter two the term perimastitis would perhaps more properly apply. The differential diagnosis of these varieties of mastitis depends upon the source of the infection and the location of septic foci, together with the degree of systemic disturbance.

In the subcutaneous form the lesion is usually single and differs little from superficial phlegmon in other parts of the body. In the glandular form more pain and more constitutional disturbance are present than in the subcutaneous variety; prodromal chill is usual; the lesion is often multiple; the gland is indurated. In the subglandular form the pain is deep seated and more intense, temperature persistent and high, the gland not indurated, and, when suppuration has occurred, it floats upon the surface of the fluid. Pus is detected by passing an aspirating needle behind the gland. Suppuration may eventuate in any of the forms, depending upon the patient's lack of power to resist the infection and upon the quantity, nature, and virility of the invading parasites. It must not be forgotten that two or all forms may coexist.

Treatment. PROPHYLACTIC AND ABORTIVE. Milk engorgement is combated by training the child early to nurse. Congestion or engorgement occurs, usually on the second or third day. A slight fever and some distress referred to the breast generally are the first symptoms. The infant should receive its first lesson as soon after birth as the condition of the mother will permit, usually within six or eight hours, and no effort should be spared in teaching the child to suckle before the milk secretion is fully established. The use of the breast-pump, as a rule, is unsatisfactory. It frequently fails, and is liable to bruise the breast.

At the hands of a skilful nurse, massage is often useful for the relief of overdistention, either of the entire breast or of single lobules. It is contraindicated in the presence of inflammation, and is permissible only when not painful. The breasts should be well oiled in order that the nurse's efforts be not expended in mere friction, but be rather a deep kneading directed to the gland. The stroking is practiced in the direction of the lactiferous ducts, from the base of the gland toward the apex.

In hypersecretion the compression-binder is an extremely valuable measure. A well-made Murphy binder is especially recommended. It is applied firmly, the pressure being evenly distributed over the breast by a moderately thick layer of cotton-wool under the binder. An opening in the centre of the cotton compress prevents injurious pressure upon the nipple. Compression is useful both as a preventive and an abortive measure in mastitis.

Topical applications of oleate of atropia are effectual for diminishing the milk secretion, but they must be used with care lest the secretion be too much repressed or the patient present an idiosyncrasy to belladonna even in small physiological doses. Saline catharsis and the restriction of liquids are especially indicated in over-free secretion.

Essential for the prevention of mastitis is the preventive and curative treatment of nipple lesions. As has already been said with reference to the prophylactic care of the mammillæ during the early weeks of lactation, it must be remembered that prolonged maceration of the nipple in the child's mouth is injurious. A single nursing need not occupy more than ten or, at the most, twenty minutes, and regularity should be insisted upon.

A part of the prophylaxis which must not be overlooked is addressed to the general health of the patient. Tonics are indicated in the majority of convalescents from childbirth.

Applications of unguentum Credé may be of service. A drachm or more should be rubbed well into the breast night and morning. The skin may also be painted with argent. nitrat. sol., 40 per cent., or an ice-bag applied over the inflammatory area.

Treatment of Suppuration. When pus forms in either variety of mastitis it should immediately be evacuated. An anæsthetic is required except in simple subcutaneous abscess. Ethyl chloride (Kelene) may be used to freeze the tissues over the area to be incised when the abscess is not too extensive, and when the type is either subcutaneous or glandular. The incision should radiate from the nipple, to avoid severing the milk-ducts, and should be large enough to admit the finger freely. When but one incision is made, it is to be located at the most dependent point of the abscess-cavity. It is well to avoid the areola, unless the incision can be kept wholly within that area. Otherwise an unsightly scar results, owing to pigmentation of the cicatrix.

The finger is then introduced and the cavity thoroughly explored. If the abscess be large, and especially if several loculi are found, counter-openings should be made at remote points. The cavity or cavities are then thoroughly irrigated with the normal salt solution or with peroxide of hydrogen. A drain of washed-out iodoform strip gauze is placed in each opening, and a large compress of aseptic cotton or cheesecloth is applied and held firmly by a breast-binder. The dressings must be changed daily for six to eight days and the irrigation, as a rule, repeated. By the end of that time the incisions may generally be allowed to close unless pus is present. One or two soft flexible rubber drainage-tubes for each opening may be substituted for the gauze, if preferred, after the first few days. The tubes should be shortened from day to day as the abscess cavity diminishes.

One of the most valuable agents in aborting mastitis is the early and continued application of cold, either by the ice-coil or, preferably, by the ice-bag. The bag should not be placed directly on the breast, but should have two or three layers of flannel between it and the surface of the breast. Continued cold applied in this manner is almost a specific for pain, and tends also to abort suppuration. It is possible that the cold may limit the rapid development of the micro-organisms, or at least check their growth from the thermal conditions present.

Tonics, milk punches, and especial attention to the regularity of the bowels are indicated.

Agalactia.

The causes of agalactia, or diminution of milk secretion to a degree below the normal, are general and special. Adynamia of any origin may

be accompanied with insufficient milk secretion. This may be due to diarrhœa, fevers, hemorrhages, serious organic lesions, insufficient nourishment, or mastitis. On the other hand, congenital or acquired malformations may be the cause. Lack of development of the glandular tissue is one of the most frequent causes, in which heredity plays an important part.

In the cases dependent upon general conditions every effort must be made during pregnancy to restore the patient's tone and vigor; and after labor liberal quantities of fluid—milk preferably—must be taken. Malt, Russell emulsion, somatose (3 or 4 teaspoonfuls daily), and foods containing phosphorus are believed to be useful. Thyroid extract, gr. j 3 to 5 times daily, is said to increase the quantity and to improve the quality of the milk. Massage of the abdomen from the pelvis to the breasts, including the latter, it is claimed increases the amount of blood brought to the mammary glands. The breasts may be stimulated by massage and by daily applications of faradism.

Congenital conditions are not amenable to treatment; whereas, acquired malformations, such as stenosis of milk-ducts, or parenchymatous degenerations due to indurative processes, can be modified in some cases by timely treatment.

As inflammatory lesions are the common local causes of these mammary changes, it is of first importance to prevent their occurrence, and if not successful to limit them as much as possible.

Galactorrhœa.

Galactorrhœa is an excessive secretion of milk which persists after weaning. The cause is unknown. The quantity of milk is very large and its quality thin and watery. One or both breasts may be affected, and the condition may seriously impair the general health.

Treatment. Treatment consists in firm compression of the breasts with a breast-binder, the exhibition of iodide of potassium, gr. x t. i. d., and the persistent use of ergot for a considerable period. Oleate of atropia may be applied locally with caution. General tonics and hæmatinics are especially indicated.

Galactocele.

Galactocele is a condition in which a mammary acinus becomes distended with milk. This may be due to congenital conditions, such as absence of the duct, stenosis, or atresia; or may result from inflammation. It is single or multiple, and may affect one or both breasts.

Treatment. Treatment is indicated where the condition is progressive, and consists either in laying the cyst open under aseptic precautions, and treating it as an abscess-cavity, or dissecting it out and closing the wound at once.

It must not be forgotten that galactocele sometimes undergoes spontaneous cure, the milk becoming inspissated and, finally, inclosed in a shrunken sac, and having the consistence of sebaceous matter.

Polygalactia.

This is an excessive secretion of milk during lactation, and is to be distinguished from galactorrhœa, in which the milk secretion persists after weaning. It is often sufficient to affect the general health.

TREATMENT. Restrict the diet, especially liquids; also regulate the patient's food. Apply compression binder, give salines, and, if necessary, evacuate the superabundant amount of milk by the breast-pump. Massage is contraindicated except in "caking."

Hyperlactation.

This occurs when the child is nursed beyond the weaning age. A recent case was reported at one of the Brooklyn hospitals; a negro boy three and a half years of age was sent by his mother to the hospital to be weaned.

Oftentimes the health of the mother in such cases suffers markedly, so much so as to demand a change of climate.

Actual treatment consists in weaning the child, prescribing tonics for the mother, and a compression-binder for a short period. The treatment advised in galactorrhœa is indicated in these cases.

CHAPTER XXVI.

PUERPERAL INSANITY.

The term *Puerperal Insanity* is applied to the psychoses of pregnancy, labor, or the puerperium. It does not indicate in itself any single form or type of insanity, but refers only to the etiology. The insanity of childbirth is far more common than those of pregnancy or lactation, Aschaffenburg fixing the proportion as follows: Insanity of pregnancy 22.7 per cent.; insanity of lactation 17.7 per cent.; and insanity of childbirth 57.6 per cent. Usually the form of mental derangement is either a symptomatic melancholia or a mania or it may be of the so-called manic-depressive form. Kraeplin is of the opinion that much of the puerperal insanity seen at a late period in asylums, of which 7 per cent. is found in the proportion of female admissions, is of the Katatonic type —the mental condition resembling acute dementia or imbecility.

As in so many other mental diseases, there must be a prepared soil, which consists in an hereditary predisposition, and here the likeness to the so-called periodical and recurrent insanities is most pronounced. While *primiparæ* are most likely to develop such mental derangement, there are many women who have repeated attacks of puerperal insanity as an accompaniment of subsequent accouchements, and doubtless its crisal development is oftentimes merely an exacerbation, the patient's mental state never being after the first attack an entirely normal one. The number of women who for the first time become insane after the second or third parturition is small in comparison with those whose disorder attends the first confinement.

Etiology. Undoubtedly there are a large number of factors both physical and mental that contribute to the production of insanity at this important epoch, and while certain variations take place in the symptomatology of the insanities coincident with the pregnant state or that following birth, the bodily and mental causes very often play a continuous part. Much stress has been laid upon the sense of shame and fear connected with the birth of an *illegitimate child*, and undoubtedly the worry and attendant suspense lead to such exhaustion and disorder as to end in the overthrow of the patient's ordinary mental condition. Strange to say, however, in the majority of cases there appears not only to be a gradual evolution of symptoms, except in a very small number of melancholic cases, but there are mania and confusion which are suggestive of a physical cause presently to be more fully referred to. It cannot be gainsaid that where conception has been the result of guilty intercourse, and where attempts have been made to produce criminal abortion, there may not only be very great mental distress and apprehension, but an undermining of physical strength, which are sufficient in themselves in certain neurotic individuals to lead to insanity. In Scotland particularly, the influence of illegitimacy is very great, 25 per cent.

of all cases occurring in the experience of one writer being those in which the offspring were illegitimate. This, according to Lewis, does not appear to be the case in England, where 61 of 66 cases observed by him were married women. After all, the importance of this element depends very much upon the moral sensibility and religious training of the community.

Among other *psychical influences* concerned in the creation of this form of insanity may be enumerated the development of the maternal instinct, the tortures of poverty, and the suffering that the woman may undergo as the result of neglect or cruelty of her husband. Among the physical causes may be mentioned certain conditions of *exhaustion* which are due to over-exertion during the months previous to delivery, the loss of blood at this time, or certain imperfectly understood forms of autotoxis. *Albuminuria*, which in former years was supposed next to local septic infection to play a part that would fully account for the puerperal psychosis, is not nowadays regarded as a sufficient explanation; in fact, the urine of the puerperal insane, as a rule, shows the absence of albumin, and there are many cases where the disease develops in women whose kidneys have from the first been unaffected. The dangers of *septic infection* from the uterine cavity itself have been equally exaggerated. Lusk, whose conservative opinions are well known, is disposed to take the view that septic infection is more likely to take place when bacteria are introduced from outside the body, and suggests that the toxæmia due to the agency of the bacterium coli is often at the bottom of wrongly ascribed toxis.

The writer's recent investigations as to the origin of insanity which is due to the *absorption of the products of intestinal putrefaction* lead him to believe that the cause of many cases of puerperal derangement is to be found in the large intestine, and that the acute symptoms, which are very characteristic, may be traced to the excessive formation of combined sulphates, and are accompanied by the presence of a large amount of indican in the urine. Whether the initial cause be exhaustion or mental worry, the disordered metabolism of proteids is a likely consequence. This theory is borne out by the investigations made by Lewis about seven years ago, namely, that there was a very decided reduction in the amount of hæmoglobin, which in five of his cases varied from 20 to 78 per cent. of the standard of healthy blood, although in one of these cases the oligochromæmia was due to post-partum hemorrhage. In all the five cases there was a lowered corpuscular value, and in one maniacal patient a rather sudden reduction attended the maniacal outburst. The well-settled conclusions arrived at by Sir Andrew Clark, Solkowski, and others, and verified by the writer's cases, show that the absorption of the products of bacterial death invariably result not only in diminished hæmoglobin, but in various alterations in the number and structure of the corpuscles themselves. As familiar causes may be mentioned *stoppage of the lochia* and the consequent retention of septic material, subsequent inflammation of the uterus itself, and the various accidents of the puerperal state, *exhaustion after a protracted labor*, an *extensive rupture of the perineum*, the suffering *incident to the use of instruments*, and the formation of *abscesses of the breast*. In a large proportion of cases the cause is to be sought in a septic or toxic condition.

Symptoms. Two forms of puerperal insanity are ordinarily recog-

nized: maniacal and melancholic, the former being much more common than the latter, the percentage varying from 70 to 80 of all the cases, and in most instances the excited or depressed state differs but little from the familiar derangement due to various non-puerperal causes. There are certain peculiarities which are so constant, however, as to be considered characteristic by many, notably the erotic manifestations and the destructiveness. The hallucinations and delusions are of a lively and rapidly formed kind, and it may be said that, whether the patient is excited or depressed, *painful* emotional states are apt to prevail. The melancholia may be of slow or rapid formation, and if it has a dominant feature it is the tendency to suicide, which is common.

Irregular mental disturbances which are so brief as not to fall under the ordinary heads of insanity, consist in delirium and temporary disturbances of a confusional nature. There is also in subjects possessing the hereditary tendency a variety of insanity characterized by the commission of impulsive acts, for which the person is very often held responsible, her ordinary conduct showing very little or no change. Within the first week after delivery the woman may present changes and an insanity develop of a most dramatic and violent nature.

There may or may not be a prodromal condition of ill health, manifested by loss of appetite, indigestion, constipation, and flatulence; but such is apt to be the case. The patient's color is usually pale, the pulse becomes irritable and quick, and a restlessness is shown which grows, and is associated with irritability, tearfulness, and pitiful complaints in regard to petty annoyances. Sleep becomes disturbed and broken, and the patient is annoyed by bright lights, noises, the slamming of doors, and is apt to be querulous and fault-finding. She expresses no interest in her child, and, in fact, does not care to see it, and when it is placed by her she is either indifferent or asks for it to be taken away. She turns against her husband, whom she subsequently accuses of infidelity; she becomes suspicious of those about her, and may say that her food is poisoned and refuse to eat it. As the condition deepens so does the excitement, while rapidly formed delusions of persecution—which at first are systematized, but afterward become disorderly and without foundation—are expressed. Auditory hallucinations as well as those of the other senses are constant, and lead her to express a fear of injury and contamination. In well-developed cases the articles about her are declared to be smeared with blood. Evil faces peer at her from every side, and she hears voices urging her to kill herself or some one else. Some women manifest exceedingly erotic eccentricities of conduct, which amount to nymphomania.

Refined and gentle women will make indecent proposals and write foul scrawls, expose their persons, and subsequently defile themselves and their bedclothing with their excrement. There are some cases of slower growth where the initial disturbance consists in a stolid silence, with a great deal of suppressed excitement which finally bursts forth. Cases are known in which women remained absolutely mute for a week or more, concealing their delusions, and ultimately, within a remarkably brief space of time, became incoherent and violent. In the depressed form of trouble there may be slowly developed delusions which sometimes have a religious coloring, and such patients are apt to accuse themselves of crimes, believ-

ing that they are the special objects of divine condemnation and are hardly fit to live. It is not at all unusual for such a patient to declare that her baby is not her own, or if it is, that it must be destroyed as a sacrifice, and that she must herself kill it, which she does. Sometimes, as a result of delusion she kills herself, or tries to, and it is not unusual for her to do this, believing that she is a burden to her husband and friends, although in the majority of cases, as has been said, the puerperal insane distrust those about them, and are filled with their own unhappy importance. The concealed form of the disease is one in which the patient may manifest a slight depression which does not reach the dignity of simple melancholia, and in which her hysterical conduct or derangement, regarded, as a rule, as ordinary neurasthenia, in reality disguises a most serious psychosis which is appreciated for the first time when some sudden and perhaps successful attempt at suicide, or some impulse resulting in destruction of her child or another person, awakens every one to the gravity of the masked disease that has perhaps existed for a long time.

The insane crimes of puerperal women are nearly always of a nature to suggest an unbalanced mind, and there is none of the concealment that belongs to child murder committed by sane persons.

Regis refers to the fact that homicide is a feature of post-partum insanity, while theft and other misdemeanors which imply a sudden instigation or a desire to satisfy, are chiefly features of ante-partum insanity.

There is no doubt of the fact that throughout the puerperal state the woman has diseased appetites and impulses, and though they may not rank very high as evidences of mental deterioration, and may disappear entirely after the re-establishment of menstruation, they at some time or other find expression in disorderly acts, some being of a criminal nature. Destruction of property, incendiarism, and the impulsive propensity to steal are not infrequently manifested, and abortive attempts at suicide lead to newspaper publicity and possibly to legal prosecution. So far as the physical evidences of puerperal insanity are concerned, we find little that is distinctive or is not associated with the ordinary insanities. The indications of malnutrition in the acute, excited and depressed psychoses are generally exaggerated, and those signs of loss of tone of the bodily functions which are the expressions of exhaustion appear much earlier than they otherwise usually do. Early and obstinate constipation, heavily loaded urine, and other indices of gastro-enteric disturbance usually commence almost as soon as, and often before, the excitement is at all marked, and may eventually resemble the so-called typhoid symptoms of various states of exhaustion. Pallor is a characteristic appearance which is common to certain other toxic insanities; the skin often has a glossy, drawn look, and the breath the so-called starvation odor. Some women at a very early time rapidly sink into a delirious condition, with occasional periods of consciousness, but without any rise of temperature, the state being erroneously called puerperal fever; in reality it is a toxæmia which varies in intensity of expression with the rapidity of absorption and the virulence of the septic poison. Sometimes the mental symptoms, as has been said, are immediately connected with the stoppage of the lochial discharge; but the discontinuance of the latter is more often an effect than a cause.

Some writers regard stuporous melancholia to be the type belonging specially to puerperal insanity, which, however, is a view the writer can hardly take, unless the familiar mute form of the disease with rigidity is to be so regarded; this seems improbable, as the subjects of the latter so often eventually express a certain intensity of feeling which undoubtedly exists in the earlier stages in a repressed form, even when the patient is most silent. Possibly this depression is but a phase of the manic-depressive psychosis described by Kraeplin and his followers, or it may be an evidence of acute dementia. The use of the term "manic-depressive," to indicate alternating emotional states occurring in psychopathic subjects, has led to much confusion—for recent writers have enunciated the somewhat extreme doctrine that there is no such thing as simple mania or melancholia except as purely symptomatic conditions. There are many who regard the term rather as defining a well-known periodical or alternating psychosis.

Prognosis. In a large number of cases there is a comparatively prompt recovery, especially in puerperal mania. The prognosis is not nearly so good in melancholia; but, of course, in both conditions much depends upon the treatment. Where an hereditary groundwork exists the situation becomes much more grave, and the danger of non-recovery is increased by the occurrence of two or more attacks. Regis does not regard any form of puerperal insanity to be as curable as simple generalized insanity. He considers that the forms occurring during gestation or labor are much more likely to get well than when the affection develops at a later period, believing that the insanity of lactation is much more serious.

So far as time is concerned, much depends upon the duration of the symptoms and upon the age of the subject. If the physician adopts prompt measures the condition may be cut short within a brief space of time, especially if the patient be a young woman; but if, as is often the case, she enters an asylum after the existence of a mania or melancholia for several months, her prospects are rather bad, for a certain mental involution has taken place which is likely to be permanent and progressive. As to age, it may be held that if puerperal insanity develops in a woman over thirty the prognosis is much more unfavorable. Lewis's figures, which may be taken, show that the recovery-rate may even reach a percentage of 80, while 8.5 per cent. represents the mortality. Of the 80 per cent. who recovered the greater number got well before the sixth month, there being 37 out of 68 cases; the others slowly recovered. It would also appear from his tables and those of Clouston that the sooner patients entered the asylum and were treated, the more rapid was their recovery. So far as the writer's experience is concerned, those who manifested suicidal tendencies or in whom the delusions were fixed and limited presented a form of the disease which is the least curable. On the other hand, in the ordinary cases, where the delusions and hallucinations are general and unstable, the prognosis is fairly good. Should a case progress, the termination of dementia is not usually so rapid as that of other forms, in this respect resembling the limited delusional insanities.

Treatment. Very much tact and care are needed in the early management of puerperal insanity, which is often difficult because of the situa-

tion of the patient and the prejudices of the family. The interference of an anxious husband is too often apt to tie the hands of a physician and to prevent him from adopting and using the wise measures of restraint that are demanded. Much of this may arise from the non-recognition of the serious nature of the complication, the friends of the woman believing it to be some temporary disturbance which may be an unimportant symptom of the puerperal condition, that will disappear in a few days. The early irritability and malaise of the woman are rarely appreciated, and the solicitous husband is apt to force his society upon his wife or to insist upon leaving the child in bed with her, despite her expressions of disgust or indifference. Anxious and sympathetic friends insist upon paying visits, and injudicious clergymen attempt a moral reform and proffer religious consolation, which has either no effect at all, or a harmful one, upon the already deranged woman. One of the first duties of the physician is to leave her alone with her nurses, who should be competent and experienced, and isolation should be rigidly enforced.

The isolation of the patient should last for a considerable time, and even when committed to an asylum it is best that she should be kept away from other patients, especially those who are apt to excite or encourage her delusions.

All things being considered, there is no reason why a patient of this kind should be removed from home, even if it were proper for her to leave her bed. But where proper facilities for nursing and restraint are not available, removal to a well-ordered asylum should be insisted upon as soon as the local conditions will permit and the diagnosis is made with certainty. It seems hardly necessary to refer to the importance of removing every possible agent with which the patient might injure herself or others; but the frequent tragedies that so often occur through neglect of this precaution must excuse a repetition of what may seem to be trivial advice. *The patient should not be left a moment alone;* all window-shutters should be properly fastened, and the room should be stripped of unnecessary furniture and especially pictures. When the patient is able to leave her bed a floor should be devoted, if possible, to her accommodation, one room being reserved for day use and the other for sleeping. It is always advisable to have a sufficient number of nurses to avoid fatiguing struggles, and instruments of restraint should not be made use of except in very rare instances. Where the mania, however, follows exhausting hemorrhage, and where the heart's action is irritable and weak, it is, of course, preferable to keep the patient in a recumbent position, which may be done by a combination camisole or a strong sheet properly fastened at the sides and foot of the bed. Some sort of mechanical restraint is permissible in destructive cases, and is not nearly so exhausting or trying as the injury that is unavoidably done by even the most humane nurses in their efforts to control the patient.

One of the first forms of medicinal treatment consists in the correction, if possible, of the intestinal condition as well as that of the uterus and vagina. Observers generally call attention to the necessity of the removal of sources of peripheral irritation or local infection. An inconsiderable focus of septic infection may give rise to an elevation of temperature, and is often associated with ill-smelling discharge and some tenderness;

it is hardly necessary to say that all retained septic material should be carefully removed, either by the curette or some other means, and the mucous membrane of the uterus and vagina should be disinfected. It is always well to give the patient a full dose of calomel and soda, which is to be followed up by such intestinal antiseptics as the salicylate of soda or naphthalin, and the lower bowel as well as the vagina and uterus should be douched with solutions of borax, carbolic acid, or the hypochlorite of sodium.

These douches should be given frequently, and large amounts of liquid are to be employed; at the same time the perineum and external organs of generation are to be washed frequently with antiseptic solutions, and proper precautions are to be taken when the bowels are moved. In some instances the use of dilute hydrochloric acid and nux vomica is of benefit, and at a later stage, when it is possible, lavage is suggested. In some patients the condition of exhaustion and depression is very great, and the administration of strychnine, either hypodermically or by the mouth, is attended with the best results. Of course, one of the earliest indications is the provision of remedies to promote sleep and to calm the excitement which is so pronounced. Our knowledge of the value of intestinal antiseptics leads us to expect most happy effects from the internal use of naphthalin, and MacPherson found that many of his most excited patients became calm and slept well after a few doses of naphthalin, which may be administered in quantities of five grains three times a day, and, if necessary, be increased to fifteen or twenty grains at a dose; should a special hypnotic be needed, there is none better than the hydrobromate of hyoscin, which may be given in doses of from $\frac{1}{100}$ to $\frac{1}{25}$ of a grain, to be repeated, if necessary, until the physiological effects are attained. Should this not succeed, the only other remedy worthy of much confidence is morphine, though chloral, the bromides, chloralamide, or paraldehyde may be tried. While chloral in light cases is better than the last two drugs mentioned, it should never be given to debilitated patients, and where the proportion of blood-corpuscles and the percentage of hæmoglobin are low, it, as well as the bromides, is contraindicated. In such examples it is much better to prescribe some such drug as paraldehyde or chloralamide. The writer does not recommend veronal, sulphonal, trional, or others of the series, which sometimes produce surprisingly bad after-effects. In some restless cases, where there is much debility, sleep may be produced by large doses of the tincture of digitalis or by alcohol. Hydrotherapy is of decided advantage as an adjunct, and a hot bath or a cold pack will often succeed where drugs fail. As has been said, the feature of puerperal insanity is physical exhaustion and malnutrition. It is, of course, necessary to put the patient upon a simple nutritious diet, which should consist for a long time of nothing but milk in generous quantities, and in the early history of the case it is not wise to give eggs or meat or substances which are apt to be imperfectly digested in the intestines. Iron, arsenic, or the gelatinous preparation of the phosphate of lime made by Leroy, of Paris, may be used at a later stage, with the effect of shortening convalescence.

So far as mental management is concerned, it is best not to resort to any systematic or aggressive measures, the patient being simply protected and furnished with congenial amusement, including free exercise in the open air.

CHAPTER XXVII.

PUERPERAL INFECTION.

By the term puerperal infection we understand the various morbid conditions of the female genital tract and the systemic affections dependent thereon which result from infection during labor or the puerperium by various micro-organisms. These infections are generally designated as puerperal fever, but we prefer to avoid the term, as it still suggests to many the old idea of the essentiality of the affection, which was so strongly urged in this country by the late Fordyce Barker.[1] It also emphasizes the febrile phenomena of the affection, instead of laying stress upon its infectious nature and the consequent responsibility of the obstetrician and his assistants. Likewise, the term puerperal infection is preferable to that of puerperal septicæmia, or sepsis, which has lately come into frequent use; for in many instances the infection results in purely localized inflammatory processes to which these terms cannot be applied without violating the established rules of diction.

It is probable that puerperal infection has occurred almost as long as children have been born, and passages may be found in the works of Hippocrates, Galen, Avicenna, and many other of the older writers which clearly referred to it. The term puerperal fever, however, is of comparatively recent origin, and was introduced by Willis in 1676, who referred to it as "febris puerperarum." The English term puerperal fever, it appears, was first employed by Strother[2] in 1718, and has continued in use ever since.

The ancients regarded the affection as the result of retention of the lochia; and this remained the prevalent explanation until a comparatively recent date. It was not until the early part of the seventeenth century that other explanations were offered, when Plater showed that it was essentially a metritis, and was followed in the next century by Puzos with his milk metastasis theory.

From the time of Plater until Semmelweiss[3] (1847) demonstrated its identity with wound infection, or, indeed, until Lister demonstrated the value of antiseptic surgery, all sorts of theories were suggested concerning its origin and nature, the consideration of which would occupy the entire space allotted to us. We would, therefore, refer those who are interested in the history of the affection to the monographs of Eisenmann (*Wund und Kindbettfieber*, Erlangen, 1837), Silberschmidt (*Historisch-kritische Darstellung der Pathologie des Kindbettfiebers, Gekrönte Preisschrift*, Erlangen, 1859, p. 131), and Burtenshaw (*The Fever of the Puerperium*, New York Med. Jour., June 4, 1904).

Organisms Causing Puerperal Infection. Although Charles White (1728-1813) and many other English observers had vague ideas as to

[1] Barker. The Puerperal Diseases, third edition, 1874.
[2] Strother. Critical Essay on Fevers. London, 1718.
[3] Semmelweiss. Die Aetiologie, der Begriff u. die Prophylaxis des Kindbettfiebers. Pest, Wien u. Leipzig, 1861.

the contagious nature of puerperal infection and its relation to wound infection, it was not until the middle part of the nineteenth century that such views were strongly urged.

In 1843, Oliver Wendell Holmes read a paper before the Boston Society for Medical Improvement entitled "The Contagiousness of Puerperal Fever," in which he clearly demonstrated that at least the epidemic forms of the affection could always be traced to the lack of proper precautions on the part of the physician or nurse. Four years later, Semmelweiss, then an assistant in the Vienna Lying-in Hospital, began to study the cause of the frightful mortality attending the confinement of women in that hospital, as compared with the small number of women succumbing to puerperal infection when delivered in their own homes. As a result of his observations he concluded that puerperal infection was wound infection, and was due to the introduction of septic material by the examining finger. He accordingly obliged every one to disinfect his hands with chlorine water or chloride of lime before examining the parturient woman, and had the pleasure of seeing the mortality fall from 10 per cent. or more to about 1 per cent. In spite of these excellent results, his work, as well as that of Holmes, was scoffed at by many of the most prominent men of the time; and it was not until after the discoveries of Lister and the development of bacteriology that their services were thoroughly appreciated.

Tarnier, in his graduation thesis in 1857, likewise strongly insisted upon its contagious nature, while Trousseau[1] the following year pointed out the the identity of puerperal and wound infection in the following words: "Quelque chose de spécifique s'ajouté à la plaie placentaire, à la plaie chirurgicale."

We shall now briefly consider the organisms which have been proved to be causes of puerperal fever:

(*a*) Streptococcus. It has been abundantly and conclusively demonstrated by many excellent observers that the streptococcus is the usual cause of the epidemic and fatal forms of puerperal infection. In 1865, before the development of cultural methods, streptococci were demonstrated by Mayerhofer[2] in the tissues of women dead of puerperal infection. His findings were confirmed by Coze and Feltz,[3] Recklinghausen,[4] Waldeyer,[5] Klebs,[6] Orth,[7] Heiberg,[8] and Landau.[9] To Pasteur[10] (1880) belongs the credit of having first cultivated streptococci from such cases, and he designated them as "chapélets en grains." He was assisted in this work by Doléris,[11] who carried it on still further and was able to demonstrate that streptococci were the usual infectious agents, but that staphylococci and, in rare instances, bacilli as well, played a part in the production of the infection. The researches of Pasteur and

[1] Trousseau. Quoted by Doléris. See note 11.
[2] Mayerhofer. Zur Frage nach der Aetiologie der puerperalen Processe. Monatsschrift f. Geburtskunde, 1865, xv. 112.
[3] Coze and Feltz. Gazette med de Strassburg, 1869, p. 30.
[4] Recklinghausen. Cent. f. med. Wissenschaften, 1871, 713.
[5] Waldeyer. Ueber das Vorkommen von Bakterien bei der diphtherischen Form des Puerperalfiebers. Arch. f. Gyn., 1872, iii. 293.
[6] Klebs. Archiv f. exper. Path., Bd. v. p. 417.
[7] Orth. Virchow's Archiv, lviii. 441.
[8] Heiberg. Die puerperalen und pyämischen Processe, 1873.
[9] Landau. Ueber puerperalen Erkrankungen. Arch. f. Gyn., 1874, vi. 147.
[10] Pasteur. Septicémie puérpérale. Bull. de l'Acad. de Méd., 1879, 260, 271.
[11] Doléris. Essai sur la pathogénie et la thérapeutique des accidents infectieux des suites de couches. Thèse de Paris, 1880.

Doléris were soon confirmed by Fraenkel,[1] Iovanovic,[2] Lomer,[3] Winckel,[4] Bumm,[5] Doederlein,[6] Winter,[7] Ott,[8] Czerniewski,[9] Widal,[10] and all subsequent observers; so that at the present time it is universally admitted that the streptococcus pyogenes is the direct causative agent in most severe cases of puerperal infection. In many instances, however, it does not occur in pure culture and may be associated with other bacteria.

(*b*) STAPHYLOCOCCUS. While streptococci are the usual causative agents in puerperal infection, it has been gradually demonstrated that they are not necessarily the only organisms which may be concerned in its production, and it has been clearly shown that most of the pus-producing organisms may likewise occasionally give rise to it.

Brieger,[11] in 1881, was the first to demonstrate that puerperal infection might be due to staphylococcus, when he reported that he had been able to demonstrate the staphylococcus aureus in 5 out of 7 autopsies. Doléris,[12] in his thesis in 1880, stated that he was able to cultivate in pure culture a coccus which was arranged in groups or bunches, but it was not until 1894 that he stated definitely that they were staphylococci. These observations were soon confirmed by other observers, among whom may be mentioned Czerniewski,[13] Fehling,[14] Haegler,[15] Doederlein,[16] Widal,[17] Mironow,[18] Netter and Bonnaire,[19] Sabrazés and Faquet,[20] Krönig,[21] and Strünckmann.[22]

It was stated by Fehling[23] and Haegler[24] that staphylococci usually give rise to mild forms of infections. But this is not always borne out by the observations of other authors. Occasionally mixed infections with the staphylococcus and streptococcus are observed, as reported by Doederlein[25] and Bar and Tissier.[26] It appears that the staphylococcus aureus is the

[1] Fraenkel. Quoted by Lomer. See below.
[2] Iovanovic. Quoted by Lomer. See below.
[3] Lomer. Ueber den heutigen Stand der Lehre von der Infectionträgern bei Puerperalfieber. Zeitschr. f. Geb. u. Gyn., 1884, x. 366.
[4] Winckel. Zur Lehr von dem internen puerperalen Erysipel. Verh. d. deutschen Ges. f. Gyn., 1886, 78.
[5] Bumm. Die puerperale Wundinfektion. Cent. f. Bakteriol., 1887, ii. 343.
[6] Doederlein. Untersuchung über das Vorkommen von Spaltpilzen in den Lochien des Uterus und der Vagina gesunder und kranker Wöchnerinnen. Arch. f. Gyn., 1887, xxxi. 412.
[7] Winter. Die Mikroorganismen in Genitalkanal der gesunden Fraun. Zeitschr. f. Geb. u. Gyn., 1888, xiv. 443
[8] Ott. Zur Bakteriologie der Lochien. Arch. f. Gyn., 1888, xxxii 436.
[9] Czerniewski. Zur Frage von den puerperalen Erkrankungen. Eine bakteriologische Studie. Arch. f Gyn., 1888, xxxiii. 73.
[10] Widal. Etude sur l'infection puérpérale. Thèse de Paris, 1889. Infection puérpérale et phlegmatia alba dolens. Gaz. des hôp:, 1889, 565.
[11] Brieger. Ueber bakteriologische Untersuchungen bei einigen Fällen von Puerperalfieber, Charité Annalen, 1888, xiii. 198.
[12] Doléris. Essai sur la pathogénie et la thérapeutique des accidents infectieux des suites de couches. Thèse de Paris, 1880. Inflammation puérpérale. Nouv. archives d'obst. et de gyn., 1894, ix. 97–122, 142–161.
[13] Czerniewski. Zur Frage von den puerperalen Erkrankungen. Eine bakteriologische Studie Arch. f. Gyn., 1888, xxxiii. 73.
[14] Fehling. Ueber Selbstinfektion. Verh. deutsche Ges. f. Gyn., 1889.
[15] Haegler. Quoted by Fehling. Physiologie und Path. des Wochenbetts, Stuttgart, 1890.
[16] Doederlein. Klinisches und Bakteriologisches über einer Puerperalfieber-epidemie, Arch. f. Gyn., 1891, xl. 99.
[17] Widal. Étude sur l'infection puérpérale. Thèse de Paris, 1889. Infection puérpérale et phlegmatia alba dolens. Gaz. des hôp., 1889, 565.
[18] Mironow. Ueber die Ursachen der puerperalen Erkrankungen. D. I. Charkow, 1889. Referat. Cent. f. Gyn., 1891, 678–680.
[19] Netter and Bonnaire. Quoted by Doléris, No. 36.
[20] Sabrazés and Faquet. Infection puérpérale staphylococcique, etc., Gaz. des hôp., 1894, 1039–1041.
[21] Krönig. Actiologie und Therapie der puerperalen Endometritis. Cent. f. Gyn., 1895, 422–432. Discussion über Endometritis. Verh. d. deutschen Ges. f. Gyn., 1895, 498–502.
[22] Strünckmann. Zur Bacteriologie der Puerperal-infection. Berlin, 1898.
[23] Fehling. Ueber Selbstinfektion. Verhand. deutsche Ges. f. Gyn., 1889, Freiburg.
[24] Haegler. Quoted by Fehling. Physiologie und Path. des Wochenbetts. Stuttgart, 1890.
[25] Doederlein. Klinisches und Bakteriologisches über eine Puerperalfieber-epidemie, Arch. f. Gyn., 1891, xl. 99.
[26] Bar and Tissier. La Semaine méd., 1896, 155. Sérothérapie dans l'infection puérpérale. L'Obstétrique, 1896, 97–128 and 204–217.

variety observed in severe puerperal infection, while the albus and citreus play little or no part in its production.

(*c*) Gonococcus. Although it had long been believed by clinicians that gonorrhœa frequently played a part in the production of puerperal infection, it was not until 1893 that Krönig[1] adduced bacteriological proof of its action. He then reported 9 cases of mild infection, in all of which he had been able to obtain pure cultures of gonococci from the uterine lochia. In a later communication he stated that he had been able to cultivate the gonococcus in 50 out of 179 cases presenting febrile puerperia, thus showing that it plays an important part in the production of puerperal disease. None of these cases resulted in death, and the great majority recovered spontaneously.

Krönig's experience has been confirmed by all subsequent investigators, and Taussig and Stone and McDonald state respectively that probably one-sixth to one-tenth of all rises of temperature in the puerperium are the result of gonorrhœal infection. As far as I am aware, Foulerton and Bonney are the only recent writers who have not had a similar experience, being unable to demonstrate the gonococcus in a series of 66 cases of puerperal infection.

Maslowsky[2] and Neumann[3] were able to demonstrate the gonococcus in the tissues in cases of endometritis deciduæ and I have repeatedly made similar observations. It is generally believed that gonorrhœal infection in the puerperium pursues a favorable course. But in very rare instances a gonorrhœal septicæmia may result, and lead to the death of the patient, as in one of my cases recently reported by Harris and Dabney.[4]

(*d*) Bacillus Coli Communis. In the writer's[5] article upon puerperal infection from a bacteriological point of view (1893) it was stated that von Franqué[6] had cultivated the colon bacillus in 1 case, and the belief was expressed that it would be demonstrated more frequently in the future. Subsequent work has amply fulfilled this prediction, and there are now on record a long series of cases due to this organism. *A priori*, this is what should be expected when one considers the proximity of the genital tract to the rectum and the ease with which contamination may occur when the obstetrician infringes the strict rules of asepsis.

Some idea of the abundance of the colon bacillus may be gained by the consideration of the figures of several French observers. Thus Vignal[7] states that one decigramme of fæces contains about twenty millions of colon bacilli; and Gilbert and Dominici[8] estimate that from twelve to fifteen billion are excreted daily with the fæces. It thus becomes apparent that the examining finger cannot avoid contamination with these organisms if it comes in contact with a non-disinfected perineum.

[1] Krönig. Vorläufige Mittheilung uber Gonorrhœa im Wochenbett. Cent. f. Gyn., 1893, 157.
[2] Maslowsky. Zur Aetiologie der vorzeitigen Ablösung der Placenta vom normalen Sitz. Monats. f. Geb. u. Gyn., 1896, iv. 212–218.
[3] Neumann. Ueber puerperalen Uterusgonorrhœa. Monats. f. Geb. u. Gyn., 1896, iv. 109–116.
[4] Harris and Dabney. Report upon a Case of Gonorrhœal Endocarditis in a Patient Dying in the Puerperium. Bull. Johns Hopkins Hospital, 1901, xii. 68–76.
[5] Williams. Puerperal Infection Considered from a Bacteriological Point of View, with Special Reference to the Question of Auto-infection. Amer. Jour. Med. Sci., July, 1893.
[6] von Franque. Bacteriologische Untersuchungen bei normalen und fieberhaften Wochenbett. Zeitschr. f. Geb. u. Gyn., 1893, xxv. 277.
[7] Vignal. Sur l'action des micro-organisms de la bouche et des matières fécales. Comptes-rend de la Soc. de Biol. Aôut., 1887.
[8] Gilbert and Dominici. Recherches sur le nombre des microbes du tube digestif. Semaine méd., 1894, p. 76.

Infection with the colon bacillus has been observed by Mironow,[1] Ahlfeld,[2] Eisenhardt,[3] Demélin,[4] Parmentier,[5] Gebhard,[6] Chantenesse[7] and Widal, Marmorek,[8] Charpentier,[9] Krönig,[10] Bar and Tissier,[11] myself, and many others.

Gebhard demonstrated its presence in 7 cases of tympania uteri, either alone or in combination with other bacteria; and Galtier[12] states that it is the organism most frequently concerned in its production. I believe, however, that this is not the case, and that Galtier's statement is probably the result of having confounded the colon with the gas bacillus.

In not a few cases the colon bacillus is associated with the streptococcus, as has been observed by Marmorek,[13] Charpentier,[14] Bar and Tissier,[15] and the writer. Some observers have thought that the combination appears to augment the virulence of the streptococcus and gives rise to very intense affections. Whether the future will demonstrate the accuracy of their statements remains to be seen.

(*e*) BACILLUS DIPHTHERIÆ. Until very recently it was believed that the "diphtheritic deposits" upon the vagina and the interior of the puerperal uterus were due to the streptococcus alone, and had nothing to do with true diphtheria. But the recent observations of Nisot,[16] Bumm,[17] Lop,[18] and the writer[19] show that this is not always the case, for we reported cases in which we were able to cultivate the Klebs-Loeffler bacillus from the diphtheritic membrane in the vagina and to cure the affection by the use of the anti-diphtheritic serum.

(*f*) PNEUMOCOCCUS. Cases have been reported by Weichselbaum,[20] Czemetschka,[21] Schuhl,[22] Vesque,[23] Burckhardt,[24] Foulerton and Bonney,[25]

[1] Mironow. Ueber die Ursachen der puerperalen Erkrankungen. D. I. Charkow, 1889. Referat. Cent. f. Gyn., 1891, 678-680.

[2] Ahlfeld. Beiträge zur Lehre vom Resorptionsfieber in der Geburt und im Wochenbette und von der Selbstinfektion. Zeitschr. f. Geb. u. Gyn., 1893, xxvii. 466–519.

[3] Eisenhardt. Puerperale Infektion mit tödlichen Ausgang verursacht durch Bakterium coli commune. Arch. f. Gyn., 1894, xlvii. 189–202.

[4] Demélin. Quoted by Barbier. Des pseudo-infections puérpérales d'origine intestinale. Thèse de Paris, 1894.

[5] Parmentier. Quoted by Barbier. Des pseudo-infections puérpérales d'origine intestinale. Thèse de Paris, 1894.

[6] Gebhard. Bacterium coli commune aus Fällen von Tympania uteri gezüchtet. Verh. deutsche Ges. f. Gyn., 1893, 305.

[7] Chantenesse. Bulletin méd., 1891, p. 1139.

[8] Marmorek. Le streptocoque et le sérum antistreptococcique. Annales de l'Inst. Pasteur, 1895, ix. 593–620.

[9] Charpentier. Sérothérapie antistreptococcique appliqué au traitement de la fièvre puérpérale. La semaine gyn., 1896, 89–92, No. 12.

[10] Krönig. Ueber Fieber intra-partum. Cent. f. Gyn., 1896, 749.

[11] Bar and Tissier. La Semaine méd., 1896, 155. Sérothérapie dans l'infection puérpérale. L'Obstétrique, 1896, 97-128 and 204–217.

[12] Galtier. De l'infection primitive du liquide amniotique après la rupture prematurée des membranes de l'œuf humain. Thèse de Paris, 1895.

[13] Marmorek. Le streptocoque et le serum antistreptococcique. Annales de l'Inst. Pasteur, 1895, ix. 593-620.

[14] Charpentier. Sérothérapie antistreptococcique appliqué au traitement de la fièvre puérpérale. La semaine gyn., 1896, 89–92, No. 12.

[15] Bar and Tissier. La semaine méd., 1896, 155. Sérothérapie dans l'infection puérpérale. L'Obstétrique, 1896, 97-128 and 204–217.

[16] Nisot. Diphthérie vagino-utérine puérpérale. Sérothérapie guérison. Annales de gyn., 1896, xlv. 259.

[17] Bumm. Ueber Diphtherie und Kindbettfieber. Zeitschr. f. Geb. u. Gyn., 1895, xxxiii. 126-136.

[18] Lop. Infection puérpérale diphthérique. Bull. de la soc., d'obst. de gyn., et depæ d. de Paris, 1904, 93–96.

[19] Williams. Puerperal Diphtheria. American Journal of Obstetrics, August, 1898.

[20] Weichselbaum. Wien. klin. Wochen., 1888, No. 28.

[21] Czemetschka. Zur Kenntniss der Pathogenese des puerperalen Infektion (Metrolymphangitis post partum) als Metastase anderweitiger durch Diplococcen bedingter Erkrankungen. Prager med. Wochen., 1894, xix. 233.

[22] Schuhl. Une epidémie d'infection puérpérale à pneumocoques. Presse méd., Aug. 21, 1897.

[23] Vesque. Des infections puérpérales non-streptococciques. Thèse de Nancy, 1899.

[24] Burckhardt. Puerperal infection mit Pneumococcus Fraenkel. Beitrage z. Geb. u. Gyn., 1901, 327, 328.

[25] Foulerton and Bonney. A case of primary infection of the puerperal uterus by diplococcus pneumoniæ. Trans. London Obst. Soc., 1903, xlv. 128.

and others in which the micrococcus lanceolatus has been demonstrated in the puerperal uterus, and Bar and Tissier[1] have observed its association with the streptococcus. While in other instances the pneumococci were carried into the uterus by the blood-current from a primary lesion.

(*g*) The Bacillus Aerogenes Capsulatus (Gas Bacillus). As our knowledge concerning the gas bacillus of Welch has become more accurate, it has been shown that it may also occasionally be concerned in puerperal infection. In 1896 the writer observed a case of this character, which was described by Dobbin in the *Bulletin* of the Johns Hopkins Hospital. Briefly stated, the case was as follows: The aid of the out-patient obstetric department of the Johns Hopkins Hospital was solicited in the case of a Bohemian woman with a generally contracted pelvis, who had been in labor for three or four days under the case of a midwife. When the patient came into our hands, the head of a macerated child was firmly engaged in the superior strait and the uterus tetanically contracted. A fetid dark-colored discharge, which contained many gas bubbles, was escaping from the vagina with a crackling sound. Owing to the softened condition of the child's head, several futile attempts at delivery were made, and we were finally forced to deliver it with Tarnier's basiotribe. The mother was profoundly infected at the time of delivery and died the next day. A few hours after death the body rapidly became intensely swollen by the development of gas in the subcutaneous tissues, and soon nearly doubled in size. Similar changes were observed in the fœtus and in the placenta, and we were able to demonstrate the presence of the gas bacillus in the fœtal and placental tissues, as well as in the uterine lochia. Unfortunately, no autopsy was allowed upon the mother, and we were, therefore, unable to say to what extent the organisms had penetrated her tissues.

Well-authenticated cases of infection with this organism have been reported by Stewart,[2] Ernst,[3] Norris,[4] Woods,[5] Halban,[6] and others, and the entire literature upon the subject was exhaustively received by Welch,[7] in 1900, and by Fraenkel,[8] in 1904.

Little,[9] in 1905, reported 10 cases in which the gas bacillus had been isolated in the Obstetrical Department of the Johns Hopkins Hospital, and pointed out that in all probability it was identical with the "vibrion septique" of Pasteur and Doléris,[10] as well as with the bacillus perfringens and other bacteria described by various writers. In only one of our cases did the bacillus occur in pure culture, while in all the others it was associated with other bacteria, particularly the streptococcus.

[1] Bar and Tissier. Sérothérapie dans l'infection puérpérale. L'Obstétrique, 1896, 97–128 and 204–217.

[2] Stewart. Bacillus aërogenes capsulatus. Columbus Med. Jour., Aug., 1893.

[3] Ernst. Ueber einen gasbildenden Anaeroben in menschlichen Körper und seine Beziehung zur Schaumleber. Virchow's Arch., cxxxiii. Heft 2.

[4] Norris. A Report of Six Cases in which the Bacillus aërogenes capsulatus was isolated. Amer. Jour. Med. Sci., Feb. 1899.

[5] Wood. Puerperal Infection Caused by the Bacillus aërogenes capsulatus. Med. Record, April 15, 1899. Ref. Cent. f. Gyn., 1900, p. 436, No. 16.

[6] Halban. Uterus-emphysem und Gas-sepsis. Monatsschr. f. Geb. u. Gyn., 1900, xi. 88–122.

[7] Welch. Boston Med. Jour., 1900.

[8] Fraenkel. Ueber die Aetiologie u. Genese der Gasphlegmonen, Gascysten u. Schaumorgane des menschlichen Körpers, Lubarsch-Ostertag, Ergebnisse der allg. Path. u path. Anat., 1904, viii. 403–471.

[9] Little. The bacillus aërogenes capsulatus in puerperal infection. Bull. Johns Hopkins Hospital, 1905, xvi, 136–146.

[10] Doléris. Inflammation puérpérale. Nouv. arch. d'obstét. et de gyn., 1894, ix. 97–122, 142–162.

As a rule the gas bacillus merely exists as a saphrophyte upon dead material, and does not invade the deeper tissues until shortly before or just after death. Accordingly the prognosis is favorable when it occurs in pure culture, but becomes very serious when it is associated with the streptococcus, as it would seem that such an association tends to augment the virulence of the latter organism. According to Welch, its presence in the puerperal uterus may give rise to emphysema of the fœtus, endometritis, physometra, emphysema of the uterine wall, and gas sepsis. Moreover, it is important to remember, as was first pointed out by Welch and Dobbin,[1] that the gas bubbles found in the bloodvessels of women supposed to have perished from "air embolism," are frequently the product of the bacillus in question. Therefore such a diagnosis is not justifiable unless careful bacteriological examination has demonstrated the absence of the gas bacillus.

(*h*) BACILLUS TYPHOSUS. In 1898 Dobbin[2] and the writer[3] isolated the typhoid bacillus, streptococcus, staphylococcus aureus, and an unidentified anaërobic gas-producing bacillus from the uterine lochia of an ignorant Bohemian, who was admitted to the Johns Hopkins Hospital on the fifth day of the puerperium with high fever. Her blood possessed the characteristic Widal reaction, but all the usual symptoms of typhoid fever were absent. The temperature fell to normal on the thirteenth day and did not rise again. We are inclined to believe that the typhoid bacilli, along with other organisms, were introduced into the uterus by the midwife, opportunity being afforded by the fact that delivery took place upon the same bed upon which her husband had died of typhoid fever a few days previously.

A somewhat similar case has been reported by Blumer,[4] in which the autopsy revealed an unexpected typhoid fever.

(*i*) BACILLARY SEPSIS. Perkins,[5] Charrin, and others have reported cases in which they believe that the bacillus pyocyaneus was the infectious agent. Moreover, isolated cases reported by Fraenkel,[6] Doléris,[7] Widal,[8] Mixius,[9] Goldscheider,[10] and others tend to show that certain cases of fatal infection may be due to bacilli with whose properties we are as yet unacquainted. But the bacteriological work upon which these statements are based is not of a character to enable us to be at all sure about the organisms in question, much less to classify them. At the same time, the bacteriological examination of the uterine lochia in large series of febrile cases, as carried out by Krönig[11] and the writer, clearly

[1] Dobbin. Puerperal Sepsis due to Infection with the Bacillus aërogenes capsulatus. Bull. Johns Hopkins Hosp., Feb. 1, 1897.

[2] Dobbin. A Case of Puerperal Infection in which the Bacillus typhosus was found in the Uterus. Amer. Jour. Obst., 1898, xxxviii. 185–198.

[3] Williams. Ein Fall von puerperaler Infection, bei dem sich Typhus-bacillen in den Lochien fanden. Centralbl. f. Gyn., 1898, No. 34.

[4] Blumer. A Case of Mixed Puerperal and Typhoid Infection, in which the Streptococcus and Typhoid Bacilli were Isolated both from the Blood and the Uterine Cavity. Amer. Jour. Obst., 1899, xxxix. 42–50.

[5] Perkins. Report of nine cases of infection with bacillus pyocyaneus. Jour. Med. Research, 1901, vi. 281–297.

[6] Fraenkel. Quoted by Lomer. See below.

[7] Doléris. Inflammation puérpérale. Nouv. archiv. d'obstét. et de gyn., 1894, ix. 97–122, 142–161.

[8] Widal. Étude sur l'infection puérpérale. Thèse de Paris, 1889.

[9] Mixius. Bakteriologische Untersuchungen einiger Fälle puerperaler Sepsis. D. I., Berlin, 1892.

[10] Goldscheider. Klinische und bakteriol. Mittheilungen über Sepsis puerperalis. Charité Annalen, 1893, xviii. 164–242.

[11] Krönig. Bakteriologie des Genital-kanales der schwangeren, kreissenden und puerperalen Frau. Leipzig, 1897.

show that many bacteria, with which we are as yet unfamiliar, may take part in the process.

(*j*) Sapræmia. Beside the cases in which the infection is due to the growth and extension of micro-organisms within the body, there is a large class of cases in which the symptoms are due to the absorption of toxic products produced by organisms within the uterus or elsewhere in the generative tract which do not make their way into the blood-current. To this form of infection Matthews Duncan applied the term "sapræmia," which has continued in use ever since. It is usually thought to be due to the invasion of the uterus by putrefactive organisms, with whose properties we are as yet almost totally unfamiliar.

There is no doubt that the term has been greatly abused, and that many cases have been included under it which really were due to infection with the ordinary pyogenic organisms, and at the present time one is hardly justified in considering a case as sapræmic unless the lochia have been examined bacteriologically and found to be free from pyogenic organisms.

This statement is borne out by the observations of Bumm,[1] who found streptococci in 8 out of 11 cases which were clinically designated as sapræmia. Von Franque[2] was likewise able to cultivate streptococci in pure culture from a case which exhibited the clinical picture of sapræmia, and as the result of his observations stated that "sapræmic fever in the puerperium is extremely rare, and should only be diagnosed when an accurate biological examination of the uterine lochia has demonstrated the absence of pathogenic and the presence of saprophytic organisms."

The organisms entering into the causation of sapræmia are mostly of an anaërobic nature and, therefore, cannot be cultivated in the usual culture-media. Many of them are gas producers and thus cause the frothy, ill-smelling secretion which is so characteristic. There is certainly a great variety of organisms which may be concerned in the production of sapræmia, though only a few have as yet been isolated. Thus, Bumm[3] was able to cultivate an anaërobic bacillus which decomposed albumin and produced poisonous substances; and Doederlein,[4] in another case presenting a frothy, purulent secretion, isolated an anaërobic gas-producing coccus. Krönig[5] in 43 abnormal puerperia found organisms which did not grow on the usual media, 32 of which grew only anaërobically.

Beside the organisms mentioned, it is not unlikely that further research will show that still other bacteria may play a part in the production of isolated cases of infection; but from what we have already said it is perfectly clear that the organisms usually concerned are the well-known pyogenic bacteria (streptococcus, staphylococcus, colon bacillus, and gonococcus) and the various putrefactive organisms.

Some idea of the frequency with which the different bacteria are concerned in the production of puerperal infections may be gained by recurring to the work of Krönig,[6] who examined bacteriologically 179

[1] Bumm. Histologische Untersuchungen über die puerperale Endometritis. Arch. f. Gyn., 1891, xl. 398.

[2] von Franque. Bakteriologische Untersuchungen bei normalen und fieberhaften Wochenbett. Zeitschr. f. Geb. u. Gyn., 1893, xxv. 277.

[3] Bumm. Ueber die Aufgaben weiterer Forschungen auf dem Gebiete der puerperalen Wundinfektion. Arch. f. Gyn., 1889, xxxiv. 325.

[4] Doederlein. Vorläufige Mittheilung über weitere bakteriologische Untersuchungen des Scheidensekretes. Cent. f. Gyn., 1894, 779.

[5] Krönig. Aetiologie und Therapie der puerperalen Endometritis. Cent. f. Gyn., 1895, 422–432. Discussion über Endometritis. Verh. d. deutschen Ges. f. Gyn., 1895, 498–502.

[6] Krönig. Op. cit.

cases of puerperal endometritis, which he classified as pyogenic, gonorrhœal, or sapræmic. The pyogenic group comprised 79 cases, in 75 of which the infective agent was the streptococcus, and in 4, the staphylococcus. In 50 cases he was able to demonstrate the presence of the gonococcus, and in 43 of the 50 sapræmic cases he was able to demonstrate organisms which did not grow on the usual culture-media, 32 of which were anaërobic.

The writer has examined the uterine lochia bacteriologically in 323 cases in which the temperature rose to 101° F. or higher during the first ten days of the puerperium, and found—

Streptococcus alone	60 cases.
Streptococcus and bacillus coli	9 "
Streptococcus and unidentified bacilli	7 "
Streptococcus and bacillus aërogenes capsulatus	5 "
Streptococcus and gonococcus	4 "
Streptococcus, bacillus aërogenes capsulatus, and bacillus coli	3 "
Streptococcus, anaërobic variety	3 "
Streptococcus, staphylococcus, gas, and typhoid bacillus	1 case.
Streptococcus, staphylococcus, gas, and colon bacillus	1 "
Staphylococcus aureus	3 cases.
Staphylococcus aureus and gas bacillus	1 case.
Staphylococcus aureus and albus and gas bacillus	1 "
Staphylococcus albus	5 cases.
Bacillus coli communis	18 "
Bacillus coli and gas bacillus	2 "
Bacillus coli and gonococcus	1 case.
Gonococcus	29 cases.
Gonococcus and gas bacillus	1 case.
Gonococcus and bacillus coli	1 "
Gonococcus and unidentified bacillus	1 "
Gonococcus and unidentified coccus	1 "
Bacillus aërogenes capsulatus	3 cases.
Unidentified anaërobic bacteria	22 "
Unidentified aërobic bacteria	6 "
Bacillus diphtheriæ	1 case.
Bacillus typhosus	1 "
Bacteria on cover-slip, cultures negative	63 cases.
Bacteria absent on cover-slip and cultures	68 "
Contaminated	2 "

Pathological Anatomy. After having thus considered more or less in detail the organisms which play a part in the production of puerperal infection, we now turn to the consideration of the lesions produced by them.

These may vary very greatly in a given case; and it is probably for this reason that the older authors did not earlier appreciate the true nature of the affection. The lesions may vary from a coated perineal tear to an inflammatory process involving the entire generative tract, and in many cases extending beyond it to the parametrium or peritoneum, and sometimes resulting in a general pyæmic infection. In other instances the infectious elements pass through the port of entry with such rapidity that they do not there give rise to local lesions, but produce a septicæmia which is rapidly fatal. These forms of puerperal infection end with extreme rapidity, and have been well designated by the French as "sepsis foudroyante." In most cases of puerperal infection, however, the disease remains limited to the endometrium, and is designated as septic or putrid endometritis, according as it is the result of the invasion of pyogenic or putrefactive organisms.

As any portion of the generative tract may be the seat of the lesion, and frequently more than one portion is involved, we accordingly have to consider puerperal vaginitis, endometritis, metritis, parametritis, metro-lymphangitis, metro-phlebitis, salpingitis, oöphoritis, peritonitis, pyæmia, and phlegmasia alba dolens.

Lesions of Vulva and Vagina. In the pre-antiseptic period the puerperal ulcer was of very frequent occurrence; but with the introduction of aseptic methods into midwifery its frequency has become markedly diminished, so that now it occurs but rarely.

These ulcers appear on the surface of tears about the vulva and perineum, and soon take on a dirty, greenish-yellow appearance, which is due to necrosis, and are bathed by a dirty purulent secretion. In some cases they become covered by a grayish-white membrane, presenting a markedly diphtheritic appearance, and were formerly designated as "diphtheritic ulcers"; but careful histological examination has shown that they have nothing in common with diphtheria except their external appearance. As a rule such ulcers about the vulva give rise to very little systemic disturbance, and would frequently pass unnoticed were it not for ocular inspection.

Puerperal Vaginitis may occur in two forms: As a diffuse, general inflammation, when the mucosa becomes thickened, soft, and reddened, and bathed with an abundant purulent secretion. In the other type, and especially when torn surfaces are present, a larger or smaller portion of the vagina may be covered by a pseudo-diphtheritic membrane, which may vary in extent from a small patch covering a slight tear to a complete cast of the entire vaginal canal.

Until recently it was believed that none of the so-called cases of diphtheria of the vagina were due to the invasion by the bacillus diphtheriæ. But the recent observations of Bumm,[1] Nisot,[2] the writer,[3] and others show that in rare instances one may have to deal with true diphtheria caused by the Klebs-Loeffler bacillus.

Endometritis. The most usual lesion in puerperal infection is an inflammation of the lining membrane of the uterus. When one recalls its condition immediately post partum, with its bleeding surfaces, its large amount of recently torn tissue, and the large gaping thrombosed placental sinuses, one readily sees how organisms which have been introduced into the uterus during labor easily find entry into its tissues. And when one considers the mechanism by which the decidua is normally removed, it is readily seen that an ideal culture-medium is prepared by Nature for the reception and propagation of organisms introduced from without.

In puerperal endometritis the infection may be limited to the placental site or may extend over the entire mucosa. When the former alone is infected, the organisms usually grow into the thrombi and produce comparatively little local reaction. On the other hand, when the entire internal surface of the uterus is affected, the endometrium becomes converted into a stinking, sloughing surface, made up of fibrin, necrotic material, and decidual débris, and bathed with a bloody, purulent discharge. The necrotic material soon takes on a dirty, yellowish-green appearance, and in many instances the ulcerated surfaces become coated with fibrin and present the clinical picture of diphtheria. This form of endometritis was formerly designated as diphtheritic, but, as stated when considering the vagina, it is not a true diphtheria, but simply a fibrinous

[1] Bumm. Ueber Diphtherie und Kindbettfieber. Zeitschr. f. Geb. u. Gyn., 1885, xxxiii. 126–136.
[2] Nisot. Diphthérie vagino-uterine puérpérale. Sérothérapie, guérison. Annales de gyn., 1896, xlv. 259.
[3] Williams. Diphtheria of the Vulva. Amer. Jour. Obstet., 1898, xxxviii. 180–185.

exudation, the result of an intense necrosis following the invasion of the usual pyogenic organisms.

Infections due to the streptococcus or staphylococcus are usually associated with little or no odor, but when due to invasion by the colon bacillus or any of the various putrefactive organisms, the interior of the uterus is bathed with a profuse foul-smelling discharge which frequently contains gas-bubbles. The amount of necrotic material produced in puerperal endometritis is often very great, and may recur with great rapidity after curetting. Fig. 395 represents the uterus from a case of puerperal infection due to the streptococcus and colon bacillus, in which the woman succumbed ten days after the birth of the child, having been

FIG. 395.

Uterus from patient dying on tenth day from a mixed infection—streptococcus and colon bacilli.

curetted three or four days before death, when it was said the uterus was scraped perfectly clean. A glance at the drawing, however, shows the entire uterine cavity filled with necrotic material, which in all probability was produced in the interval elapsing between the curettage and the time of death.

In most cases the infection remains limited to the endometrium, but frequently it progresses beyond it, giving rise to a metritis, a lymphangitis, or a phlebitis, as the case may be. The extension of the process beyond the endometrium usually occurs through the lymphatics, and one may trace in their course areas of inflammation extending from the endometrium to the peritoneal surface of the uterus. In other cases, and especially where the infection has been limited to the placental site, the

thrombi may be invaded by the micro-organisms, resulting in a phlebitis which may remain limited to the uterine wall or may rapidly extend far beyond it along the ovarian or internal iliac veins up as far as the junction of the renal veins with the vena cava, and give rise to the various thrombotic forms of infection.

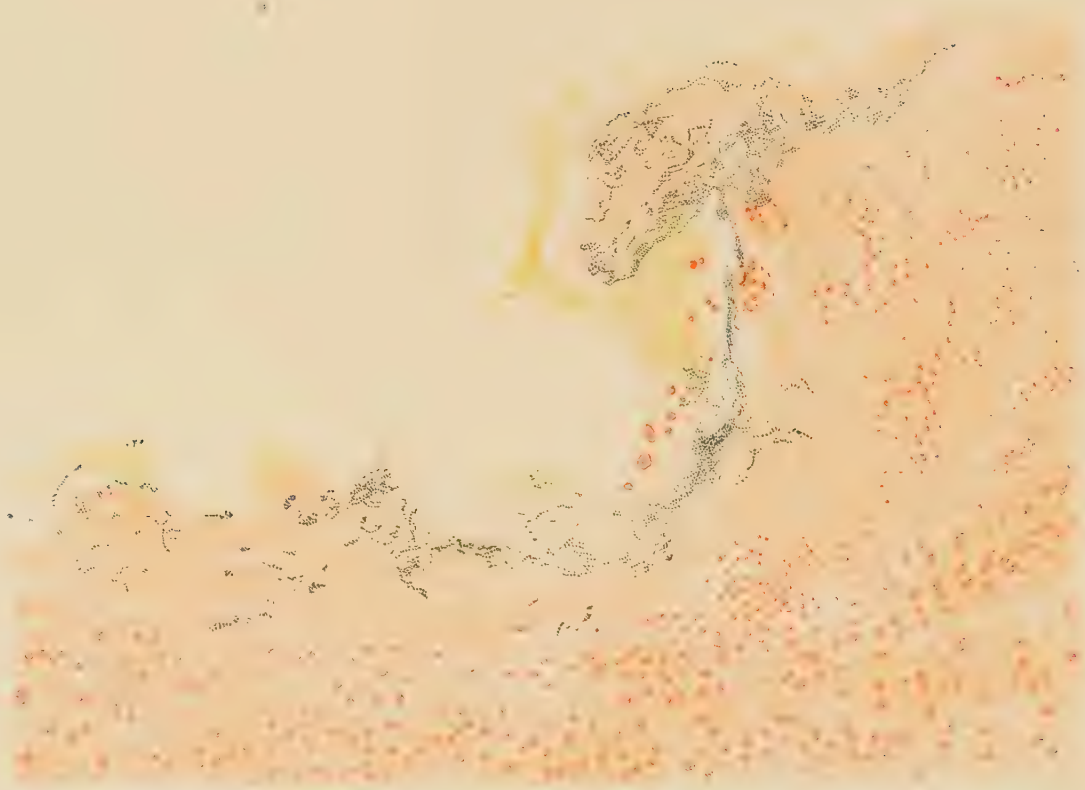
The lesions produced in the endometrium vary very considerably according to the micro-organisms concerned, and particularly according to their virulence. In the cases in which one has to deal with a virulent streptococcus or staphylococcus infection, the local changes may

FIG. 396.

Uterus from patient dying on tenth day from a pure streptococcic infection.

be comparatively slight, the process rapidly spreading through the lymphatics or veins past the uterus, and giving rise to a peritonitis or a general systemic infection. Whereas, in the cases due to the putrefactive organisms, as well as those due to the colon bacillus and to the ordinary pus-organisms of lesser virulence, the process remains more or less limited to the endometrium and gives rise to marked local lesions. Fig. 396 represents the uterus from a woman dying of a virulent streptococcic infection, and shows that its interior is almost perfectly smooth, and presents nothing which could have been removed by means of the curette, and stands in marked contrast to the case

PLATE XXXIV.



Section through Decidua and Uterine Wall, showing Streptococci. (Doederlein.)

PLATE XXXV.

Fig. 1.

Section through Decidua from Putrid Endometritis, removed by Curette on Ninth Day (Bumm.)

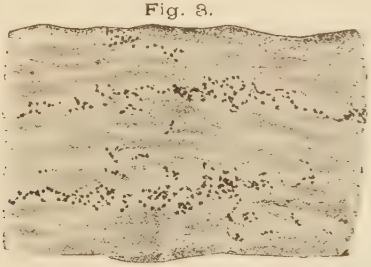
a, necrotic tissue swarming with bacteria; *b*, zone of reaction, showing nuclei of leukocytes.

Fig. 2.

Section through Decidua. Septic Endometritis, Curetting on Seventh Day. (Bumm.)

a, necrotic tissue, bacteria in masses; *b*, resisting zone of leukocytes; *c*, lumen of glands; *d*, cross-section of bloodvessels; *e*, remnants of epithelial cells of uterine glands.

Fig. 3.



Streptococci Growing between Muscle Fibers. (Bumm.)

figured above, in which the infectious agents were the streptococcus and colon bacillus.

Moreover, when one studies the histology of puerperal endometritis one finds these differences still further accentuated. Most of our knowledge on this point we owe to the researches of Bumm[1] and Doederlein,[2] both of whom have shown that there is a marked histological difference between the putrid and septic forms. According to Bumm, in sections through the walls of a uterus the seat of a putrid endometritis a thick layer of necrotic material is found lining the uterine cavity, and imbedded in it are found large numbers of the offending micro-organisms. Beneath this lies a thick layer of small-cell infiltration, which may be designated as the zone of reaction, and beneath it more or less normal tissue. The bacteria are limited almost entirely to the superficial necrotic layer; a few may be found in the reaction zone, but none in the tissues beneath it, thus showing Nature's mode of preventing the invasion of the body by the micro-organisms. (See Plates XXXIV. and XXXV.)

Such conditions are observed not only in the cases due to infection with putrefactive organisms, but also in those in which the pyogenic organisms possess only a slight degree of virulence. On the other hand, in cases of septic endometritis, and especially when the organisms are virulent, a totally different appearance obtains. Here, likewise, one finds adjoining the uterine cavity a layer of necrotic material, which, however, is usually thinner than in the preceding case. The zone of small-cell infiltration is either lacking or very imperfectly developed, and micro-organisms may be seen making their way down through the decidua and along the lymphatics through the muscular wall of the uterus out to its peritoneal surface. The writer has been able abundantly to confirm the observations of Bumm, whose conclusions are amply justified.

The effect produced by various micro-organisms was strikingly illustrated in one of the writer's cases, in which he had to deal with a double infection with the streptococcus and colon bacillus. On sections through the uterine wall the characteristic necrotic zone was seen lining the cavity of the uterus and in it both forms of micro-organisms. Beneath this the zone of small-cell infiltration was fairly well developed, and in its upper part contained both forms of organisms. But in its lower portion only streptococci were present, which continued their way through the uterus by means of the lymphatics, and on reaching the peripheral surface gave rise to a peritonitis. It would, therefore, appear that Nature endeavors to confine the micro-organisms to the interior of the uterus by interposing between the necrotic layer and the deeper portions a wall of small-cell infiltration, which acts as an efficient filter when they are not virulent, but which fails to restrain them when they possess a marked degree of virulency.

PARAMETRITIS. One of the most frequent complications of the uterine infection is parametritis, which is usually due to the propagation of the micro-organisms from the uterus to the peri-uterine connective tissue

[1] Bumm. Histologische Untersuchungen über die puerperale Endometritis. Arch. f. Gyn., 1891, xi. 368.

[2] Doederlein. Die Beziehungen der Endometritis zu den Fortpflanzungsvorgüngen. Verh. d. deutschen Ges. f. Gyn., 1895, 224-242.

by means of the lymphatics. The first effect of their invasion is a marked inflammatory œdema, but very little or no suppuration. In mild cases the infection goes only thus far, while in more severe cases it rapidly spreads to the surrounding connective tissue and eventuates in abscess-formation. In the latter instance the infectious agents may follow the course of the lymphatics behind the peritoneum, when they may give rise to retroperitoneal phlegmons, which in rare cases may extend up as high as the posterior mediastinum. On the other hand, when they follow the lymphatics, which extend into the anterior portion of the pelvis, inflammatory phenomena may occur about the inguinal canal, and in some cases, following the connective tissue surrounding the greater vessels of the thigh, give rise to phlegmasia alba dolens.

Occasionally the parametritic involvement originates from infected tears about the cervix, but in the vast majority of cases it is due to infection from the uterine cavity.

As has already been pointed out, in a considerable number of cases the endometritic process extends into the uterine wall, and there gives rise to the various lesions of *metritis*, which may vary from small areas of small-cell infiltration to marked abscess-formation. In the majority of such cases, however, the abscesses are most abundant in the peripheral portion of the uterus, on account of the richer supply of lymphatics just beneath the peritoneum.

Salpingitis. In a certain proportion of cases the process extends directly from the uterine cavity to the Fallopian tubes, and there gives rise to various inflammatory phenomena. Occasionally, however, the salpingitis is due to infection through the lymphatics and not by continuity from the uterine cavity. Exceptionally, *oöphoritis* occurs, when the ovaries become enlarged to several times their usual size and are very œdematous. The process may stop here or go on to typical abscess-formation. The ovarian infection in the vast majority of cases is due to lymphatic involvement, and is usually coincident with affections of the parametrium. More rarely, however, the ovarian process may be due to direct infection of a ruptured follicle by means of the peritonitic fluid.

Peritonitis. The fatal termination in most cases of puerperal infection is due to peritonitis. As was pointed out when considering the histological changes in puerperal endometritis, the streptococci or other infecting agents make their way by means of the lymphatics from the interior of the uterus to its peritoneal surface, and there give rise to peritonitis. This is the usual mode of infection; but exceptionally the peritoneum is infected by pus which escapes from the Fallopian tubes, though in none of the autopsies which the writer has witnessed upon women dead of puerperal fever was such an origin noted. More rarely the peritonitis is due to the rupture of a parametritic or ovarian abscess; while in not a few cases of criminal abortion it follows instrumental perforation of the uterus or vaginal cul-de-sac.

Pyæmia. The pyæmic form of puerperal infection usually results from the infection of thrombi at the placental site and subsequent inflammatory changes occurring in the veins. The thrombosis may be limited to a comparatively small area and be entirely within the uterine wall, or it may extend beyond the uterus, and occasionally all the pelvic vessels

are thrombosed up as high as the junction of the renal veins with the inferior vena cava.

By the breaking down of the thrombi, small particles escape into the circulation and are carried by the blood-current to various parts of the body, where they give rise to metastatic abscesses, from which no portion of the body is exempt, though they occur most frequently in the lungs and joint cavities. In other cases blebs or bullæ due to the same cause appear on various portions of the body, and in their contents the offending micro-organisms may readily be demonstrated.

Less frequently, detached particles of thrombi may be arrested in one of the larger vessels of the lungs and give rise to pulmonary embolism and almost instantaneous death. When smaller vessels are involved the results are not so serious, though the portion of lung supplied by them becomes infarcted and gives rise to a secondary pleurisy or pneumonia, which may ultimately lead to death. It would appear from the observations of Mahler,[1] Breuer,[2] and Richter[3] that a large part of the pulmonary affections occurring in puerperal women originate in this manner, and in not a few instances the appearance of a localized pleurisy may be the first manifestation of a serious thrombotic process.

In most cases of pyæmia there is usually but little uterine involvement, and when death occurs it is due to the general exhaustion following a prolonged suppurative process rather than to peritonitis, which is the usual cause of death in other forms of infection.

Phlegmasia Alba Dolens. As was pointed out when considering the question of parametritis, this affection is sometimes the result of an extension of the process to the tissues surrounding the greater vessels of the thigh by means of the lymphatics. More usually, however, it is due to the extension of a thrombotic process from the pelvic vessels; and in several of my autopsy cases the thrombosis could be traced from the uterus to the common iliac vein, whence it extended upward to the vena cava and downward to the vessels of the leg.

Occasionally, in cases which recover, the phlegmasia appears to be an isolated process, though it is probably only a part of a much more extensive thrombosis. Moreover, it should be borne in mind that even widespread thrombosis may give rise to but slight clinical manifestations, as in one of my cases, in which at autopsy the femoral vein and all its branches were completely occluded; careful mensuration was necessary to detect any difference in the size of the legs.

Phlegmasia alba dolens should always be regarded clinically as a manifestation of infection; although it may possibly be of other origin. Thus, my assistant, F. C. Goldsborough,[4] described a case of complete occlusion of the common iliac, external iliac, and femoral veins, which was clearly the result of pressure. Such an inference, however, is not permissible unless the case comes to autopsy, and careful bacteriological examination demonstrates the absence of bacteria.

An excellent idea of the frequency of the various lesions in fatal cases of puerperal infection may be gained from the statement of Kneise,[5] who

[1] Mahler. Thrombose, Lungenembolie u. plötzlicher Tod. Arbeiten aus der Frauenklinik. Dresden, 1895, ii. 72–120.
[2] Breuer. Ueber puerperale Pleuritis und Pneumonie. Chrobak's Festschrift, 1903, i. 399–417.
[3] Richter. Thrombose und Embolie im Wochenbett. Archiv f. Gyn., 1905, lxxiv. 122–142.
[4] Goldsborough. Thrombosis of the internal iliac vein during pregnancy. Bulletin of the Johns Hopkins Hospital, 1904, xv. 193–196.
[5] Kneise. Zur Kenntniss der reinen Septikämie. Archiv f. Gyn., 1904, lxxiii. 333–350.

studied the autopsy reports from 89 cases in Halle, with the following results:

Peritonitis	43 cases.
Thrombo-phlebitis	20 "
Pyæmia	17 "
Parametritis	7 "
Sepsis fondrayante	2 "

Etiology. From the consideration of the various bacteria concerned in puerperal infection, it is evident that we have to deal with the same organisms with which we are familiar as causing wound-infection; and, generally speaking, we may say that puerperal infection is caused by the introduction of pathogenic organisms into the generative tract, either during or immediately after labor. In other words, we have to deal with a direct infection from without, the infectious germs being brought to the woman by the hands, instruments, or any object which comes in contact with her generative organs.

Therefore, puerperal infection is contact-infection, and this conception was first definitely enunciated by Semmelweiss[1] in 1847, in the following words: "I consider puerperal fever, not a single case excepted, as a resorption fever, caused by the resorption of a decomposed animal-organic material. The first result of the absorption is a change in the blood, and the exudations are the result of this change. The decomposed animal-organic material, which when resorbed causes childbed fever, is brought to the individual from without in the greatest majority of cases, and this is infection from without. These are the cases which represent the epidemics of childbed fever; these are the cases which can be prevented."

In the latter part of the last century puerperal fever began to be considered as a contagious malady in England. This conception apparently originated with Thomas Kirkland,[2] of Ashby, in 1774, but was first clearly enunciated in 1795 by Gordon, of Aberdeen, in his treatise "On the Epidemic of Puerperal Fever, as it prevailed in Aberdeen from December, 1789, to March, 1792," in which he gave a table of 77 cases which he had attended himself.

In this country the greatest part in introducing the conception of the contagious or infectious nature of the affection was played by Oliver Wendell Holmes,[3] who in 1843 wrote an article on "Puerperal Fever as a Private Pestilence," in which he clearly showed that it was a preventable affection, and owed its origin either to the accoucheur or midwife. His teachings, however, did not exert the influence which might have been expected; for they were opposed by the leading obstetricians of the country, notably Meigs[4] and Hodge of Philadelphia, the former stating that he preferred to consider puerperal fever as due to the workings of Providence, which he could understand, rather than to an unknown infection of which he could form no conception.

For many years the prevalent theory in Europe attributed its causation to miasmatic or atmospheric influences. This view was held until after the appearance of Semmelweiss's article in 1861, although in 1874 Hirsch,[5] after studying the matter from an historical point of view,

[1] Semmelweiss. Die Aetiologie der Begriff u. die Prophylaxis des Kindbettfiebers Pest, Wien u. Leipzig, 1861.
[2] Kirkland. Treatise on Childbed Fever, 1774.
[3] Holmes. Puerperal Fever as a Private Pestilence. Boston, 1865.
[4] Meigs. On Childbed Fever. Phila., 1854.
[5] Hirsch. Historisch-pathologische Untersuchungen über Puerperalfieber. Erlangen, 1864.

came to the conclusion that it was of infectious rather than of miasmatic origin.

It was not, however, until Lister had introduced antiseptic methods into surgery, and Stadtfelt, of Copenhagen, had recommended the use of bichloride of mercury in obstetrics, that the great mass of the profession began to understand that puerperal fever was due to contact-infection, and could be prevented to a very great degree. After the bacteriological work of Pasteur[1] and his successors, and the constant finding of streptococci in fatal cases, the question was raised above all doubt, and at the present time no one doubts its infectious nature.

Modes of External Infection. The most usual mode of infection is by the hands of the obstetrician or the midwife, and no one who has observed the way in which the average medical man conducts a labor case can wonder that puerperal fever occasionally occurs. The introduction of dirty instruments, as well as dirty hands, plays an important part in the production of the infection. A source of infection which is frequently overlooked is coitus during the latter weeks of pregnancy; and I have seen two women die in my out-patient department who had not been examined internally, and, upon seeking an explanation for the infection, found that they had copulated during the first stage of labor. Not infrequently, especially among the lower classes, the woman may infect herself by fingering the genitalia or even by making internal examinations. Contact with secretions from wounds of any kind also plays an important part in its production, and whether the purulent secretion be from an external wound or from within the body, the result will be the same. It is only necessary to recall in this connection the case of Dr. Rutter of Philadelphia, who was followed wherever he went by an epidemic of puerperal fever, while his brother practitioners were practically free from it. It appeared later that the source of infection in his cases was an ozæna, from which he was constantly infecting his hands.

The disease is often due to wounds on the hands of the nurse, and many cases may be traced to bone-felons and other affections of the fingers, and not infrequently to a pustulous eczema on the hands.

For many years it has been known that physicians attending cases of erysipelas, and then going to women in labor, frequently had to deal with puerperal infection, and one of the old ideas concerning the disease was that it was identical with erysipelas; and it was not until bacteriology showed that both erysipelas and most cases of puerperal infection are due to the streptococcus that this relation was understood. At the present time the majority of observers believe that there is no essential difference between the streptococcus erysipelatis of Fehleisen and the ordinary streptococcus pyogenes. Moreover, it has frequently been observed that puerperal fever also occurs in the practice of those attending diphtheria and scarlet fever and occasionally typhoid cases. There is no essential relationship between these affections, but in both diphtheria and scarlet fever one frequently meets with complications which are due to the streptococcus, and these are conveyed to the woman in labor.

It was formerly held that air-infection played an important part in the production of puerperal infection, and many advise covering the external

[1] Pasteur. Septicémie puérpérale. Bull. de l' Acad. de Méd., 1879, 260, 271.

generative organs with an occlusive pad, to prevent the entry of air within the vagina in order to avoid this source of infection. It appears to us, however, that air-infection, if it ever occurs, is a very infrequent cause of the disease, and we cannot indorse the statements of Garrigues,[1] in which he attributed an epidemic of puerperal fever in the New York Lying-in Hospital to the presence of a dead rat in the cellar. It is much more probable that the epidemic was due to imperfect hand-disinfection on the part of his assistants or to the introduction of pathogenic organisms within the vagina by the hands of the patients themselves. In England, and to a slight extent in this country, sewer-gas is believed to play a prominent part in the production of puerperal infection, and some years ago at a meeting in London, at which the writer was present, a prominent medical man stated that the first duty of the obstetrician on visiting the house of his patient was to inspect the sanitary arrangements instead of making a physical examination. Moreover, the writer was informed by good authority that after the serious illness of a prominent woman from puerperal infection, in one of the smaller towns of England, the entire sewerage system was torn up to discover the leak from which the sewer-gas had escaped, which was supposed to have been the cause of the disease. There can be no doubt that the danger of infection from this cause has been greatly exaggerated, and it will be spoken of less and less frequently as medical men become better versed in the technique of rigorous hand-disinfection.

To show what an accurate conception Semmelweiss[2] had of the various modes of contact-infection, it may be interesting to quote what he said in this connection: "The bearer of the decomposed animal-organic material is the examining-finger, the operating-hand, instruments, bed-clothes, the atmospheric air, sponges, the hands of the midwife or nurses which come in contact with the excrement of women sick with puerperal fever, and after that handle pregnant and parturient women. In other words, the bearer of the decomposed animal-organic material is anything which is soiled by a decomposed animal-organic material and comes in contact with the genitals of these patients."

Auto-infection. Every one at the present time believes that the vast majority of cases of infection are the result of the introduction from without of pathogenic micro-organisms into the genital canal of the pregnant or parturient woman by means of the examining-finger or in some other way. At the same time, many also believe that in a certain number of cases the infection does not occur in this manner, but owes its origin to micro-organisms which were already within the woman before the onset of labor. To this class of infections the term "auto-infection" is applied. The term originated with Semmelweiss, who stated: "In rare cases the decomposed animal material, which causes childbed fever when absorbed, is produced within the patient herself. These are the cases of auto-infection and cannot be prevented."

With the enthusiasm which attended the introduction of antiseptic methods into midwifery, the conception of auto-infection was lost sight of for a time, and it was only when the statistics of well-conducted lying-

[1] Garrigues. Puerperal Infection. American Text-book of Obstetrics, 1895, 683–734.
[2] Semmelweiss. Die Aetiologie der Begriff u. die Prophylaxis des Kindbettfiebers. Pest, Wein u. Leipzig, 1861.

in establishments showed that a certain amount of infection occurred in spite of the rigorous application of antiseptic principles that the idea was rehabilitated by Ahlfeld[1] and Kaltenbach.[2] Of course, with the recognition of the fact that puerperal fever is due to definite micro-organisms, the definition introduced by Semmelweiss[3] fell to the ground, as it is not possible for the bacteria to originate spontaneously within the body of the woman. The conception was then introduced by Kaltenbach[4] that in a considerable number of cases pathogenic organisms are normally found in the vaginæ of pregnant women, and may be carried into the uterus by the introduction of a perfectly sterile finger within the vagina. It is apparent in such cases that one does not have to deal with auto-infection in the strict sense of the word, and much confusion would have been avoided had the term indirect infection been substituted for it; because the micro-organisms must have been introduced into the vagina at some period of life, and the question simply resolves itself into one of time. Certain observers, notably Slavjansky[5] and Szabo,[6] state that auto-infection, even in this modified sense, is not possible, and that all cases of puerperal infection are due to the introduction of pathogenic micro-organisms at the time of labor.

This appears to be an extreme view, and the question must stand or fall with the results of the bacteriological examination of the generative tract in the pregnant and non-pregnant conditions. If careful investigation shows that pathogenic micro-organisms are absent from the uterus and vagina of pregnant women, the doctrine of auto-infection must be abandoned. If, on the other hand, they can be demonstrated in apparently healthy women during pregnancy, its possibility must be admitted, no matter what our preconceived ideas may have been.

Practically all bacteriological investigators are united in claiming that the body of the normal uterus is free from micro-organisms, both before and during pregnancy. This fact has been amply demonstrated by the work of Goenner,[7] Doederlein,[8] Winter,[9] Ott,[10] Czerniewki,[11] Stroganoff,[12] Krönig and Menge,[13] and Doederlein and Winternitz,[14] while Strauss and Sanchez-Toledo[15] and Denzler[16] have demonstrated the same in the lower animals.

[1] Ahlfeld. Beiträge zur Lehre von Resorptionsfieber im Wochenbett und von der Selbstinfektion Berichte und Arbeiten, 1883, i. 165. Beitrag zur Lehre der Selbstinfektion. Cent. f. Gyn., 1887, 729.

[2] Kaltenbach. Zur Antisepsis in der Geburtshülfe Volkmann's Sammlung klin. Vorträge. Nr. 295. Ueber Selbstinfektion. Verh. deutschen Ges. f. Gyn, Freiburg, 1889.

[3] Semmelweiss. Op. cit.

[4] Kaltenbach. Ueber Selbstinfektion. Verh. deutschen Ges. f. Gyn., Freiburg, 1889.

[5] Slavjansky. Die Antiseptik in der Geburtshülfe. Verh. de x. internat. med. Congresses, 1891, iii. Abth. vii. 1.

[6] Szabo. Zur Frage der Selbstinfektion. Arch. f. Gyn., 1889, xxxvi. 77–101.

[7] Goenner. Ueber Mikroörganismen in Sekrete der weiblichen Genitalien während der Schwangerschaft und bei puerperalen Erkrankungen. Centralbl. f. Gyn., 1887, 444.

[8] Doederlein. Untersuchung über das Vorkomen von Spaltpilzen in den Lochien des Uterus und der Vagina gesunder und kranker Wöchnerrinnen. Arch. f. Gyn., 1887, xxxi. 412.

[9] Winter. Die Mikroörganismen im Genitalkanal der gesunden Frau. Zeitschr. f. Geb. u. Gyn., 1888, xiv. 443.

[10] Ott. Zur Bacteriologie der Lochien. Arch. f. Gyn., 1888, xxxii. 436.

[11] Czerniewski. Zur Frage von den puerperalen Erkrankungen. Eine bakteriologische Studie. Arch. f. Gyn., 1888, xxxiii. 73.

[12] Stroganoff. Bakteriologische Untersuchungen des weiblichen Genitalschlauches. Centralbl. f. Gyn., 1897, 935. Bakteriologische Untersuchungen des Genitalkanales beim Weibe in verschiedenen Perioden ihres Lebens. Monatsschr. f. Geb. u. Gyn., 1895, ii. 365–399, 494–504.

[13] Krönig and Menge. Scheidensekret-untersuchungen bei 100 Schwangeren. Aseptik in der Geburtshülfe. Centralbl. f. Gyn., 1894, 3–10.

[14] Doederlein and Winternitz. Die Bakteriologie der puerperalen Sekrete. Hegar's Beiträge zur Geb. u. Gyn., 1900, iii. 161–174.

[15] Strauss and Sanchez-Toledo. Septicémie puérpérale expérimentale. Nouv. Arch. d'obstét. et de gyn., 1889, cv. 277–295.

[16] Denzler. Die Bakterienflora des gesunden Genitalkanals des Rindes, etc. D. I. Zürich, 1904.

Prior to 1898 it was generally admitted that the puerperal uterus was normally sterile, and the fact that it contained bacteria was considered to afford prima facie evidence of infection. In that year, however, Burckhardt[1] stated that the uterine lochia of 93 per cent. of apparently normal puerperal women contained bacteria and in many instances streptococci. Two years later his findings were confirmed by Franz,[2] but were almost immediately controverted by Doederlein and Winternitz. The latter observers found the uterine lochia sterile in 83 per cent. of 250 cases and considered that the remaining 17 per cent. of positive results were to be attributed to mild infections which gave rise to few, if any, symptoms.

Since then a very considerable literature has accumulated upon the subject, which unfortunately has not served to settle the controversy, one set of observers contending that the uterine lochia are sterile in the great majority of cases, while the other set holds diametrically opposite views, although neither claims that they are always sterile. In most instances the bacteria cultivated did not belong to the ordinary pyogenic group, although Stolz,[3] Schenck, and Scheib[4] found streptococci in 36 to 38 per cent. of their cases. On the other hand, they were absent in the series of cases studied by Foulerton and Bonney and Brownlee.

In view of these contradictory findings, H. M. Little,[5] at my suggestion, examined the uterine lochia from 50 consecutive women delivered in the Obstetrical Department of the Johns Hopkins Hospital. Cultures were taken in each case immediately after delivery, as well as upon the 3d and 9th days of the puerperium, and, not counting the gonococcus, were found to be sterile in 96, 85 and 70 per cent. of the cases respectively. In no instance was the streptococcus found.

Our observations would therefore indicate that the normal puerperal uterus at no time contains the usual pyogenic bacteria, but, at the same time, it cannot be regarded as sterile except immediately after delivery; and moreover, that it becomes progressively more and more contaminated as the puerperium advances.

The conclusions concerning the bacterial contents of the cervix in the healthy woman are not uniform. Some observers state that micro-organisms are present in the cervical canal in most cases; while others hold that they are usually absent.

These contradictory results were apparently satisfactorily reconciled by Walthard's[6] work. He found that cultures taken from the lower portion of the cervical canal contained identically the same micro-organisms as the vagina, but that they became less plentiful as the internal os was approached, disappearing altogether about one-third of the way up. It would therefore appear that the observers who found bacteria in the cervix obtained the secretion from the lower portion of its canal; while those who reported negative results obtained it from higher up.

[1] Burckhart. Ueber den Keimgehalt der Uterushöhle bei normalen Wöchnerrinnen. Centralbl. f. Gyn., 1898, 686–689.

[2] Franz. Bakteriol. und klinische Untersuchungen über leichte Fiebersteigerungen in Wochenbette. Hegar's Beiträge zur Geb. u. Gyn., 1900, iii. 51–100.

[3] Stolz. Studien zur Bakteriologie des Genitalkanales in der Schwangerschaft u. im Wochenbett. Beiträge z. Geb. u. Gyn., 1903, vii. 406–421.

[4] Schenk and Scheib. Die Stellung u. Bedeutung des Streptococcus pyogenes in der Bakteriologie der Uteruslochien normalen Wöchnerrinnen. Zeitschr. f. Geb. u. Gyn., 1905, lvi. 325–350.

[5] Little. The Bacteriology of the puerperal uterus. American Jour. of Obst., 1905, lii. 815–847.

[6] Walthard. Bakteriologische Untersuchungen des weiblichen Genitalsekretes in der Gravidität und in Puerperium. Arch. f. Gyn., 1895, xlviii. 201–269.

Accordingly, we may conclude that both the uterus and the upper portion of the cervix are practically, if not absolutely, sterile; and can, therefore, offer no possibility for the occurrence of auto- or indirect infection with the usual pyogenic bacteria.

The question accordingly resolves itself into the demonstration of the presence or absence of pathogenic micro-organisms in the healthy vagina, and, according as this can be done, the doctrine of auto-infection must be generally accepted or absolutely abandoned. Ahlfeld,[1] in all his articles upon the subject, states that "the vagina is swarming with various varieties of pathogenic organisms, and auto-infection can only be prevented by thoroughly disinfecting the vagina in every case by antiseptic douches."

Unfortunately, the bacteriological investigations as to the bacterial contents of the vaginal secretion of pregnant women have not led to absolutely satisfactory and conclusive results. On the one hand, the work of Goenner,[2] Thomen,[3] Samschin,[4] Krönig and Menge,[5] Bensis,[6] and the writer,[7] in 1898, appears to show that pathogenic micro-organisms, with the exception of the gonococcus, cannot be found; while, on the other hand, numerous investigators have demonstrated the presence of streptococcus in a varying proportion of their cases, as shown by the following table:

	Per cent.		Per cent.
Burckhardt[8]	4	Winter	15
Steffeck[9]	4	Williams[16] (1893)	20
Doederlein[10]	4.1	Vahle[13]	25
Burguburu[11]	8.5	Walthard	27
Koblanck[12]	9.5	Stolz	30
Vahle[13]	10	Bumm	74
Witte[14]	12.5	Natvig	100
Kottmann[15]	13		

Thus it seems, on the one hand, that bacteriological work appears to prove that auto-infection is absolutely impossible; while, on the other hand, it indicates that it may occur in a varying percentage of cases.

The appearance in 1892 of Doederlein's work on the vaginal secretion appeared to reconcile for a time the conflicting results.

[1] Ahlfeld. Beiträge zur Lehre von Resorptionsfieber im Wochenbett und von der Selbstinfektion. Berichte und Arbeiten, 1883, i 165. Beiträg zur Lehre der Selbstinfektion. Centralbl. f. Gyn., 1887, 729. Beiträge zur Lehre von Resorptionsfieber in der Geburt und im Wochenbette und von der Selbstinfektion. Zeitschr. f. Geb. u. Gyn., 1893, xxvii. 466–519.

[2] Goenner. Loc. cit.

[3] Thomen. Bakteriologische Untersuchungen normaler Lochien und der Vagina und Cervix Schwangerer. Arch. f. Gyn., 1889, xxxvi. 231.

[4] Samschin. Ueber das Vorkomen von Eiterstaphylococcen in den Genitalien von gesunder Frauen. Deutsche med. Wochen., 1890, 232.

[5] Krönig and Menge. Loc. cit.

[6] Bensis. Récherches sur la flore vulvaire et vaginal chez la femme enceinte. Thèse de Paris, 1900.

[7] Williams. The Bacteria of the Vagina and their Practical Significance, based upon the Bacteriological Examination of the Vaginal Secretion of 92 Pregnant Women. Amer. Jour. Obstet., 1898, xxxviii. 449–483.

[8] Burckhardt. Ueber den Einfluss der Scheidenbakterien auf dem Verlauf des Wochenbettes. Arch. f. Gyn., 1893, xiv. 71–94.

[9] Steffeck. Bakteriologische Begründung der Selbstinfektion. Zeitschr. f. Geb. u. Gyn., 1890, xx. 339.

[10] Doederlein. Das Scheidensekret. und seine Beudeutung für das Puerperalfieber. Leipzig, 1892.

[11] Burguburu. Zur Bakteriologie des Vaginalsekretes Schwangeren. Arch. f. exper. Path. und Pharmak., Nov., 1892, xxx.

[12] Koblanck. Zur puerperalen Infection. Zeitschr. f. Geb. u. Gyn., 1899, xi. 85–92.

[13] Vahle. Ueber das Vorkomen von Streptococcen in der Scheide Gabärender. Zeitschr. f. Geb. u. Gyn., 1896, xxxv. 192–215.

[14] Witte. Bakteriologische Untersuchungschefunde bei path. Zustünde im weibl Genitalapparat. mit besonderer Berücksichtigung der Eiterreger. Zeitschr. f. Geb. u. Gyn., 1892, xxv. 1.

[15] Kottmann. Beiträg zur Bakteriologie der Vagina. Arch. f. Gyn., 1898, lv. 615.

[16] Williams. Puerperal Infection, considered from a Bacteriological Point of View, with Special Reference to the Question of Auto-infection. Amer. Jour. Med. Sci., July, 1893.

He pointed out that the vaginal secretion might occur in one or two forms, which he designated as normal and pathological. The former was a thick, dry, cheese-like material, of a whitish color and distinctly acid reaction. Microscopically it contained epithelial cells, a pure culture of tolerably long bacilli, and now and then a few yeast-fungi. It did not contain pathogenic micro-organisms and offered absolutely no support for the doctrine of auto-infection. On the other hand, the pathological secretion was fluid, generally of a yellowish color, suggesting pus, and occasionally contained gas-bubbles. In it were found large numbers of leucocytes, many micro-organisms of various kinds, and in a few cases streptococci. Its reaction was less acid than the normal secretion, occasionally neutral, and in a few cases even alkaline.

Doederlein's work was based upon the examination of 190 pregnant women, 55.3 per cent. of whom presented normal, and 44.6 per cent. pathological, secretion, while in 10 per cent. of the latter he was able to demonstrate the presence of streptococci by cultural methods. His investigations, accordingly, indicated that auto-infection could not possibly occur in women with normal secretion, whereas it was theoretically possible in 10 per cent. of the pathological cases. He supposed that the contradictory results of previous investigators could be reconciled by supposing that those obtaining negative results had worked with the normal, and those obtaining positive results with the pathological, secretion.

Krönig,[1] in 1897, stated that he had examined the vaginal secretion of 167 pregnant women, and that in none of them was he able to demonstrate typical streptococci or any other pathological micro-organisms, with the exception of the gonococcus. He, therefore, concluded that the vaginal secretion should be considered as practically sterile, and that it did not offer the slightest evidence in support of the doctrine of auto-infection. He stated that in all probability the conflicting results of the various observers were due to the different methods by which they obtained the secretion for examination; and that whenever it was obtained by means of a speculum it was probable that pathogenic micro-organisms had been carried up along with it from the vulva. To avoid this he recommended that it be obtained by means of a small tube, which could be introduced into the vagina under the guidance of the eye, without coming in contact with the labia minora or the margins of the hymen.

In 1898, the writer[2] reported to the American Gynecological Society the results which he had obtained from the examination of the vaginal secretion of 92 pregnant women, from whom he had obtained the secretion by means of a small tube similar to that employed by Krönig and Menge. In no case did he find the streptococcus or staphylococcus aureus, but in 6 cases he demonstrated the staphylococcus epidermidis albus. Whether the latter really existed in the vagina or were due to contamination is open to doubt; but as these organisms are never found in severe cases of puerperal infection, their presence is a matter of indifference as far as the question of auto-infection is concerned. He accordingly stated that he could confirm Krönig's[3] obser-

[1] Krönig. Bakteriologie des Genitalkanales der schwangeren, kreissenden u. puerperalen Frau. Leipzig, 1897.

[2] Williams. The Cause of the Conflicting Statements Concerning the Bacterial Contents of the Vaginal Secretion of the Pregnant Woman. Amer. Jour. Obstet., 1898, xxxviii. 807–817.

[3] Krönig. See note 1.

vations as to the absence of pyogenic cocci from the vaginal secretion of pregnant women, and, therefore, believed that auto-infection due to them could not occur, although he was not prepared to state that it might not occasionally occur from other bacteria, especially in some of the cases of putrefactive endometritis.

These conclusions were absolutely contradictory to those of the writer in 1893, when he was able to confirm Doederlein's[1] original work by finding streptococci in 20 per cent. of the cases which he examined. The only possible explanation for the different results obtained in the two series of investigations must be sought in the manner in which the secretion was obtained for examination, as all the other conditions under which the work was carried out were identical. In the first series the secretion was obtained by means of a sterile glass speculum, and in the second by means of Menge's tube; and it appeared probable, when the speculum was used, that a number of bacteria were carried into the vagina by it from the margins of the hymen and the inner surface of the labia minora, with which it had come in contact; while such contact was avoided when the tube was employed, and the secretion obtained absolutely free from contamination.

This explanation was placed beyond doubt by the examination of 25 additional cases by the writer, from each of which three sets of cultures were made. The first were taken from the hymen and inner surface of the labia minora, the second from the vaginal secretion obtained by means of Menge's tube, and the third from the vaginal secretion obtained by means of a sterilized speculum. Pyogenic cocci or colon bacilli were demonstrated in 80 per cent. of the first series of experiments, in none of the second, and in 48 per cent. of the third series, thereby showing conclusively that the vaginal secretion is absolutely free from pyogenic cocci when obtained without contamination; but that bacteria are usually present upon the hymen and labia minora, and that it is impossible to introduce a speculum into the vagina without carrying them along with it in at least one-half of such cases.

On the other hand, the recent work of Stolz,[2] Bumm and Sigwart,[3] Natvig,[4] Walthard and Reber, and others tends to show that streptococci are present in from 30 to 100 per cent. of all cases, and thus casts considerable doubt upon the conclusions of Krönig and Menge and myself. These investigators, however, are conscious of the difficulty of their position, and have attempted in various ways to explain the comparative infrequency of streptococcic infection, which theoretically should be of common occurrence if the vaginal streptococci were virulent and of the same character as those concerned in the usual infections. All attempts to demonstrate any inherent difference have thus far been futile, and Reber has taken refuge in the supposition that the patient gradually acquires an immunity against her own streptococci, and can become infected only when they come from some other source.

[1] Doederlein. Das Scheidensekret. und seine Beudeutung für das Puerperalfieber. Leipzig, 1892.
[2] Stolz. Studien zur Bakteriologie des Genitalkanals in der Schwangerschaft u. Wochenbett. Beiträge z. Geb. u. Gyn., 1903, vii. 406–421.
[3] Bumm and Sigwart. Untersuchungen über die Beziehungen der Streptococcen zum Puerperalfieber. Beiträge zur Geb. u. Gyn., 1904, viii. 329–336.
[4] Natvig. Bakteriologische Verhältnisse im weiblichen Genitalsekrete. Arch. f. Gyn., 1905, lxxvi. 701–859.

It is interesting to note that Bumm, in 1904, scoffed at my explanation of the varying results of the different observers, and stated that the only explanation for negative results is to be sought in the employment of unsuitable culture media. He then reported the results obtained in the examination of the vaginal secretion from 103 pregnant women. After introducing a speculum, he obtained the secretion from a portion of the vaginal wall which had presumably not come in contact with it, and then inoculated into bouillon. When a single examination was made, streptococci were demonstrated in 38 per cent. of the cases, which became increased to 74 per cent. if the cultures were taken upon several occasions.

These results were so surprising, and at such variance with my own that I requested my assistant, John M. Bergland, to repeat Bumm's experiments, employing exactly the same technique and culture media. At the same time he took occasion to repeat my previous work. For this purpose, 50 consecutive normal pregnant women were employed, and cultures taken as follows:

1. From the vulva before disinfection,
2. From the vagina by means of Menge's tube,
3. From the vagina by means of a speculum following Bumm's technique.

In each group, cultures were made in bouillon, following Bumm's method, as well as upon solid media.

In group 1 the cultures were nearly always positive. In group 2 always negative as far as pyogenic cocci were concerned; while in group 3 positive results were obtained in more than half of the cases in which bacteria had been demonstrated upon the vulva.

These observations, which have not yet been published, confirm *in toto* my previous work, and demonstrate conclusively to my mind that the vaginal secretion, when properly obtained, is sterile as far as pyogenic bacteria are concerned, and also that a speculum cannot be introduced into the vagina except at considerable risk of carrying up bacteria from the vulva.

It is important to note, even when positive results were obtained by Bergland, that streptococci were found but rarely, their place being taken by staphylococci and colon bacilli. It would, therefore, be interesting to find an explanation for this difference, as it is impossible to believe that so competent a bacteriologist as Bumm could have confounded other bacteria with streptococci, while at the same time it is hardly possible that the bacterial flora of the vulva could vary so greatly in Baltimore from that observed in Berlin and Halle.

As a result, therefore, of the work just mentioned, as well as that of Krönig and Menge and the writer, we consider that it has been fairly satisfactorily demonstrated that pyogenic cocci are not present in the vagina of pregnant women, and that, therefore, there is no possibility of auto-infection as far as they are concerned; and, accordingly, whenever they are demonstrated in the uterine lochia of puerperal women, they should be regarded as distinct evidence of external infection.

At the same time it is possible, in rare instances, that auto-infection may occur from other organisms which are found in the vaginal secretion, and plausibility is lent to such a supposition by the increasing frequency with which bacteria are found in the uterus with the advance

of the puerperium, but satisfactory evidence cannot be adduced in support of such an occurrence until methods have been devised which will enable us to isolate and cultivate satisfactorily in pure cultures the organisms in question, many of which are anaërobes which will not grow upon the usual media.

The gonococcus forms an exception in this regard, as it is well known that it is the only pyogenic coccus which can live and thrive in the normal vaginal secretion. As we have already indicated, it is not infrequently the cause of an elevation of temperature during the puerperium. But such cases should not be considered as supporting the doctrine of auto-infection, for the reason that women were usually infected either before conception or in the first few months of pregnancy, after which the organisms persist in the crypts of the cervical canal, where they live as parasites, and simply find more suitable conditions for development in the first few days of the puerperium, when they make their way up into the uterine cavity and manifest their presence by the production of fever and an increased discharge.

Likewise, one should not regard as auto-infection, in the strict sense of the word, those cases in which the bacteria are brought to the uterus from distant foci of disease by means of the blood-current, nor those in which the process results from some pre-existing affection of the generative tract, such as an old pyosalpinx.

An interesting fact in connection with the question of auto-infection is that those who believe most in its possibility, and resort to the employment of the prophylactic vaginal douches for the destruction of the organisms in the vagina, present far less favorable statistics than those who take the opposite view. Thus, for example, Ahlfeld, who is the most pronounced believer in auto-infection, finds that 38 per cent. of his cases present a rise of temperature, even after the use of the prophylactic douche. The results of Kaltenbach, who was a consistent believer in auto-infection, and resorted to the routine employment of the prophylactic douche, have undergone a very material improvement since Fehling discontinued its use, after taking charge of the clinic in Halle. Moreover, the results of Leopold and Mermann, who do not use the douche at all, show constant improvement, with the increasing precision with which objective asepsis is carried out.

The prophylactic value of the vaginal douche has recently been investigated by Krönig[1] and Bretschneider,[2] and the latter reports 2280 cases from the Leipzig Clinic, in which every alternate case was douched. The puerperium was febrile in 45.18 per cent. of the cases in which the douche was used, as compared with 36.78 per cent. of the cases in which it was not employed; while a still more pronounced difference was reported by Norris[3] in 1904.

Jewett,[4] in 1896, quoted the opinions of most American obstetricians on this subject, and it would appear that most of them do not employ the prophylactic douche; and that, while a certain number theoretically

[1] Krönig. Klinische Versuche über den Einfluss der Scheiden-spülungen während der Geburt auf den Wochenbettsverlauf. Münchener med. Wochen., 1890, No. 1.
[2] Bretschneider. Klinische Versuche über den Einfluss der Scheidenspülungen währen der Geburt auf den Wochenbettsverlauf. Arch. f. Gyn., 1901, lxiii. 453–471.
[3] Norris. The Prevention and Treatment of Puerperal Infection. Amer. Med., 1904, vii. 256–260.
[4] Jewett. The Question of Puerperal Self-infection. Amer. Gyn. and Obst. Jour., 1896, viii. 417–429.

believe in auto-infection, they practically act as if its occurrence were impossible.

Frequency. It is very difficult to make accurate statements as to the frequency of puerperal infection, especially when it occurs outside of hospital practice; especially as the consideration of the vital statistics of the various cities fails to give any idea as to the frequency with which the disease occurs, because the vast majority of deaths from it are not reported as such, but as due to malaria, typhoid fever, pneumonia, etc. This is due to the fact that the laity have learned that puerperal fever is a preventable affection, and when it occurs are inclined to lay the blame upon the physician in charge of the case, which he usually attempts to shirk by stating that death was due to some other affection.

That the tables prepared by the various health officers give no idea as to the frequency of death from puerperal infection is made very evident by the statement of Reynolds,[1] who in 1893 attempted to write an article upon the prevalence of puerperal fever in Boston, but on looking over the statistics furnished by the health office he found that he had seen during that year, if the reports of the department were accurate, more than one-fourth of all the cases of this character in Boston.

Since the introduction of antiseptic and aseptic methods into midwifery the mortality from puerperal infection has diminished very markedly in hospital practice. In the old maternity of Paris and in the lying-in hospital of Vienna, not infrequently, the mortality varied between 10 and 15 per cent., and in some months every case ended fatally. Just before the introduction of antiseptic methods the frightful mortality occurring in such institutions attracted the attention of the public at large, and steps were being instituted to abolish them as a menace to public health. With the introduction of aseptic methods, however, all this has changed, and in well-regulated lying-in institutions at the present time the mortality from sepsis is usually only a small fraction of 1 per cent. Accordingly, at present, in discussions upon puerperal infection, at least as far as hospitals are concerned, the question is one of morbidity rather than of mortality—namely, the number of patients whose temperature during the puerperium rises above 38° C. (100.4° F.).

On the other hand, in private practice it is questionable whether the results of to-day are materially better than before the introduction of antiseptic methods. At the present time one rarely hears of epidemics of puerperal infection such as occurred previously, and which are mentioned in the historical work of Hirsch,[2] who gives the particulars of 216 epidemics occurring between the years 1652 and 1862.

At the same time, it would appear that puerperal infection is almost as frequent in private practice now as thirty years ago, for the reason that the doctrines of asepsis have not yet permeated the rank and file of medical men, much less those of the midwives, in whose hands a very large proportion of all obstetrical cases occur.

Bacon,[3] in an article based upon the records of the health depart-

[1] Reynolds. The Frequency of Puerperal Sepsis in Massachusetts, etc. Boston Med. and Surg. Jour., cxxxi. 153–155.

[2] Hirsch. Historisch-pathologische Untersuchungen über Puerperalfieber. Erlangen, 1864.

[3] Bacon. The Mortality from Puerperal Infection in Chicago. Amer. Gyn. and Obst. Jour., 1896, viii. 429–446.

ment of Chicago, for forty years prior to 1896, showed that puerperal infection still plays a very prominent part in the death list, and stated that 12.75 per cent. of all women dying between the ages of twenty and fifty years succumbed to puerperal sepsis. In 1873, 20 per cent. of all women dying between these ages perished from it. Since then the mortality has gradually fallen, reaching 6 per cent. in 1892 and 7.3 per cent. in 1895. These results are substantiated by those of Ingerslev,[1] who states that even at the present time in Denmark, with the single exception of tuberculosis, puerperal infection is the most frequent cause of death in women between the ages of twenty and fifty years.

The investigations of Boxall[2] and Byers[3] show a similar condition in England, where it may be said that, outside of the lying-in hospitals, this affection claims as many and perhaps more victims than formerly.

Moreover, in considering the frequency of puerperal infection we should not be guided altogether by the consideration of its mortality, for the great proportion of cases do not result in death. But any one who has an opportunity of observing numbers of gynecological cases cannot fail to be impressed with the very large proportion which owe their origin to febrile affections during the puerperium, which are preventable for the great part, and are due to the neglect of aseptic precaution on the part of the physicians in charge.

Symptomatology. According to the statements of Labadie-Lagrave and Basset,[4] we rarely meet with the virulent forms of puerperal infection with which our predecessors had to deal. They consider that the vast majority of cases represent attenuated forms of the affection, whose modified course, in all probability, is due to the more or less rigorous application of antiseptic principles, with a consequent diminution in the virulence of the offending organisms.

As stated when considering the pathological anatomy of puerperal infection, its most usual manifestation is an endometritis, which may be either of the septic or putrid variety, whose symptoms vary considerably.

In the cases of septic endometritis everything goes smoothly for the first three or four days of the puerperium, when the patient suddenly experiences more or less malaise, possibly has a headache and a chill, after which the temperature rises to 103° F. or higher. Generally but one chill occurs, while the temperature remains constantly elevated. At the same time there is considerable tenderness in the lower part of the abdomen, the uterus is larger and more doughy in consistency than normal, and is more or less sensitive on pressure. The lochial discharge is usually increased in quantity and is a bloody, more or less purulent secretion, which in the purely septic forms is practically devoid of odor. If the temperature is very high the discharge is not infrequently diminished in amount, and may occasionally almost disappear. The absence of odor in these cases is of the greatest practical importance, since the average practitioner associates puerperal infection with profuse and foul-smelling lochia; while the fact is that in its most viru-

[1] Ingerslev. Die Sterbilchkeit an Wochenbettfieber in Dänemark und die Bedeutung der Antiseptik für disselle. Zeit. f. Geb. u. Gyn., 1893, xxvi. 443.
[2] Boxall. Mortality in Childbed. J. Obst. and Gyn. Brit. Emp., 1905, vii. 315–343.
[3] Byers. Mortality from Puerperal Infection in England and Wales. Amer. Jour. Obstet., 1901, xliv. 433–441.
[4] Labadie-Lagrave and Basset. La sépticémie puérpérale attenué (étude bacteriologique). Congrès period. internat. de gyn. et d'obstét., 1892. Brux., 1894, i. 319–325.

lent forms, and especially those due to pure streptococcus infection, there is very little, if any, odor to be noticed.

Another point of importance is the faulty involution of the uterus. This must be looked upon as a factor which plays an important part in the further spread of the disease; for, as has already been stated, the micro-organisms make their way through the muscular wall of the uterus by means of the lymphatics, and, when it is markedly relaxed, it is apparent that the lymph-channels must be more patent and offer less resistance to their outward passage than when the uterus is firmly and normally contracted.

The further history of septic endometritis varies according as the process remains limited to the cavity of the uterus or extends beyond it. In the former case the temperature gradually falls, the secretion becomes less profuse, and the patient is slowly restored to health. In the majority of cases, however, the uterine mucosa is not restored to its normal condition at once, but for a long time remains in a condition of subacute or chronic inflammation. If the process extends beyond the uterus the symptoms will vary according to the organs involved, and the clinical picture will be complicated by the appearance of symptoms characteristic of a parametritis, peritonitis, or pyæmia.

In putrid endometritis the symptoms vary considerably from those of the septic form. The initial chill and the high temperature likewise occur, but the patient's condition does not usually appear so serious. The main difference, however, is to be noted in the character of the uterine discharge, which in the putrid cases is abundant, very foul-smelling, and frequently contains large numbers of gas-bubbles, which give it a frothy appearance. These cases usually recover and only rarely end fatally.

Between these two well-marked classes of cases, however, there exist all gradations, as one frequently has to deal with mixed infections due to pyogenic as well as putrefactive organisms.

As already indicated when considering the pathological anatomy of the puerperal ulcer, it is not infrequent to find the chill and rise of temperature associated with an ulcer about the vulva or somewhere in the vagina. In the vast majority of cases, however, this does not occur alone, but is usually associated with an endometritis, and the same may be said of puerperal vaginitis.

If the process has extended from the uterine cavity or from ulcers about the cervix to the parametrium, the symptoms are more or less characteristic. In many cases the initial rise of temperature gradually disappears, and we are congratulating ourselves that the patient has escaped so easily, when suddenly there is a chill and the temperature rises again, and then pursues a more or less irregular course, usually marked by exacerbations in the evening.

This may continue for a longer or shorter period without any local manifestation, but sooner or later a mass may be felt on one or both sides of the uterus, which is due to abscess formation within the folds of the broad ligament. Such an abscess may be limited to the broad ligament itself, or may follow the lymphatics of the pelvic connective tissue along the anterior portion of the pelvis up to the neighborhood of Poupart's ligament, or extend backward toward the retroperitoneal

region. The temperature will continue until the abscess ruptures spontaneously or has been opened with the knife, except in the few cases in which it undergoes gradual resorption, leaving a mass of cicatricial tissue to mark its former situation. Unless the parametritic abscess ruptures into the peritoneal cavity the patients usually recover. If not operated upon the abscess may burst into the rectum or bladder, and occasionally through the abdominal wall into the inguinal region.

In a certain number of cases the infection extends from the uterine cavity to the Fallopian tubes, and there gives rise to a salpingitis with its accompanying symptoms, and many a case of pyosalpinx, which is operated upon later, is the result of such a process.

Unfortunately, the infection does not always remain limited to the uterus or the parametrium, but the micro-organisms make their way through the lymphatics of the muscular wall of the uterus to the peritoneum, where they give rise to peritonitis. Only exceptionally is it due to the extension of the process from the tubes or to the rupture of a parametritic abscess or pyosalpinx.

Occasionally the peritoneal involvement is limited to the portion lining the pelvic cavity, when we have to deal with a pelvic peritonitis. If the process remains limited, the chances are that it will eventuate in recovery; but if a greater portion of the peritoneum be involved, the death of the patient is to be predicted. The characteristic symptoms of peritonitis may make their appearance at almost any time during the puerperium, but rarely before the third or fourth day or later than the end of the first week, unless following the rupture of an abscess.

When the patient is infected with virulent streptococci the endometritic involvement is usually very slight, and the first sign of infection appears from the side of the peritoneum. Here we notice the initial chill and the temperature remains constantly elevated; the pulse becomes rapid and in the latter part of the affection very weak and thready. The patient usually complains of intense pain, which is at first limited to the lower portion of the abdomen, but gradually extends over the entire abdomen. At the same time there is marked tympanites and the abdominal walls are rendered firm and tense by the distended intestines. If a fatal issue ensues death usually occurs within the first ten days of the puerperium, the patient gradually sinking and dying in a conscious condition. Exceptionally these characteristic symptoms are lacking, and the serious condition of the patient is indicated only by the rapid and compressible pulse and a haggard and drawn facies.

In the cases of pyæmia, on the other hand, the clinical picture is very different. Here the initial chill does not occur so soon and the temperature does not remain constantly elevated, but instead presents a typical hectic course, with the alternating chill, high temperature, and remission. The symptoms also vary very considerably, according as the condition is the result of the dislodgement of a single thrombus or of the constant supply of small portions of infected thrombi to the circulating blood. In the first instance we have a metastasis produced at some one point, whose symptoms will vary according to the organ involved. On the other hand, if thrombi are being constantly dislodged, we may have symptoms referable to various organs.

One of the most constant symptoms of pyæmia is an infectious broncho-

pneumonia which frequently leads to a fatal termination. In other cases swellings appear at the various joints, which frequently eventuate in suppuration and may lead to their total destruction. Abscesses may also develop in the internal organs or appear upon the surface, and in several instances the author has seen them lead to destruction of the eye. The course of pyæmia varies very materially according to the organs involved and the power of resistance of the patient, but is nothing like so uniformly fatal as the peritonitic form of infection.

In a certain number of cases the infection is so virulent that the organisms do not have a chance to become localized in any one organ, and we find them and their toxins in very large numbers in the blood, with very slight involvement of the uterus. This we designate as septicæmia, which is the most rapidly fatal form of infection; the patients in many instances dying on the second or third day of the puerperium in a condition of shock and without the development of local symptoms, the writer having recently observed a case of pure streptococcus infection in the out-patient department, which ended fatally eighteen hours after the initial rise of temperature.

Not infrequently the thrombotic process extends into the femoral or saphenous vein and gives rise to phlegmasia alba dolens. This usually does not make its appearance until some time in the second week of the puerperium or later, when the patient begins to complain of more or less pain along the line of the femoral vessels in one limb and soon notices a swelling of the part, which extends from above downward. In such cases the thrombosed vein can be palpated as a rigid cord just beneath Poupart's ligament. This affection is extremely painful and usually lasts for a considerable time, but does not lead to death unless the patient succumbs to the original infectious process or to pulmonary embolism resulting from the dislodgement of a portion of the thrombus. In many cases of phlegmasia the onset of the disease is associated with pain about the chest. This symptom has been dwelt upon by Pinard and Wallich[1] in their work on the treatment of puerperal infection, and is due to the occlusion of small vessels of the lung by minute emboli, with subsequent infarction and the development of isolated areas of pleurisy.

Occasionally infection may occur before the birth of the child. These we designate as "*intra-partum* infection." This usually occurs in slow labors in which the membranes ruptured at an early period. In such cases the temperature may be markedly elevated and the patient present a markedly septic appearance during the progress of labor. When the temperature rises above 100.5° F. one should always think of this complication, which should indicate the speedy termination of labor.

Diagnosis. The diagnosis of puerperal fever does not usually offer any difficulty, as the clinical history is very significant.

If a patient who has been previously well has a chill and rise of temperature on the third or fourth day of the puerperium, we may be practically sure that we have to deal with an infection, unless we can account for the symptoms by some other perfectly apparent cause. In many cases the initial chill does not occur and we simply have the rise of

[1] Pinard and Wallich. Traitement de l'infection puérpérale. Paris, 1896.

temperature. In general terms, it may be said that a temperature of 100.4° F. or higher, which persists for more than twenty-four hours, is *a priori* evidence of infection.

In the old times it was believed that the onset of the lacteal secretion was accompanied by fever, and the older observers always looked for a rise of temperature on the third or fourth day and designated it as "milk fever." At present, however, we no longer believe in its occurrence, as we know that the normal puerperium should be absolutely free from fever. It is customary, in speaking of the puerperium, to consider a rise of temperature to 100.4° F. (38° C.) as within the bounds of normal. But when this point is reached we are obliged to look for some cause for the temperature, which in the vast majority of cases will be found in an infection from without.

After the infection has become well established, either as endometritis, peritonitis, or one of the other forms, the diagnosis is usually easy. In the case of puerperal endometritis in which there is no involvement of the peritoneum or parametrium, usually very little pain is observed, and it occasionally becomes a difficult matter to decide positively whether the temperature is due to a uterine infection or to some other cause.

In a certain number of instances a rise of temperature may occur on the third or fourth day of the puerperium, as the result of excitement, fright, or grief. In such cases the temperature rises suddenly and may reach a considerable height, but promptly falls within a few hours to the normal. Such cases at the onset may simulate an infection, and it is only by the rapid subsidence of the symptoms that we are able to make a diagnosis.

More frequently a rise of temperature may be caused by auto-infection from the intestinal tract. Special attention has been devoted to this subject by Budin[1] and Galtier,[2] who state that in some instances such a condition may closely simulate puerperal infection. The diagnosis is readily made, however, by the administration of a stong laxative, for after a copious movement of the bowels the temperature rapidly falls and remains at the normal line.

We not infrequently notice a rise of temperature occurring in the early part of the puerperium which is due to inflammatory troubles about the breasts, but the subsequent history of the case speedily clears up the diagnosis.

These are the most usual causes of rises of temperature which are not connected with puerperal infection. At the same time many intercurrent affections, accompanied by a chill and high temperature, may for a short time suggest puerperal infection; but the subsequent history of the case soon teaches that our fears are groundless. This is frequently the case in angina and the acute pulmonary affections, which may occur at any time during the puerperium.

There are two diseases, however, which are frequently confounded with puerperal fever and which are also made the scapegoat to shield the practitioner who has neglected aseptic precautions in the conduct of his case. These are malarial and typhoid fever. While there is no doubt

[1] Budin. La Semaine méd., 1896, 155.
[2] Galtier. De l' infection primitive du liquide amniotique après la rupture prematurée des membranes de l'oeuf humain. Thèse de Paris, 1895.

that either of these affections may occur during the puerperal period, it is nevertheless true that such a diagnosis is usually made in order to shield the practitioner from the consequences of his own neglect.

Occasionally, in prolonged suppurative processes about the pelvis, we have symptoms which may readily be confounded with one or other of these affections, but in the present state of our knowledge there is no reason why we should long remain in doubt as to the cause and origin of the fever in a given case. In malaria we should be able to demonstrate, in the blood, the presence of the malarial plasmodium, and unless this is done we do not consider that such a diagnosis is justified.

The writer in his own practice goes still further, and would not attribute a rise of temperature in the puerperium to malaria to the exclusion of puerperal infection unless he had found malarial organisms in the blood of the patient, and likewise demonstrated by cultural methods that the uterine cavity was free from all pathogenic organisms, as it is possible in exceptional cases that puerperal infection may be associated with malarial poisoning. Judged by these criteria, malaria complicating the puerperium will occur far less frequently than is at present said to be the case.

The diagnosis of typhoid fever is very frequently made in post-puerperal infections, and is based by the average observer upon the long continued fever and the general prostration of the patient. While the writer has observed several cases of true typhoid fever complicating the puerperal state, he is confident that the vast majority of cases so designated are really examples of puerperal infection. He, therefore, holds that such a diagnosis should be made only when a positive Widal reaction can be demonstrated.

On the other hand, the existence of typhoid fever may be overlooked and the symptoms attributed to puerperal infection. Jung has described several such cases, where their nature was not recognized until autopsy. I have likewise seen a case in which the two conditions were combined. In this instance the cultivation of bacteria from the uterine lochia enabled me to diagnosticate the infection during life, while the existence of typhoid fever was not suspected until autopsy.

Likewise, an acute miliary tuberculosis, or the flaring up of a chronic process during the puerperium, may occasionally simulate an infection or may mask its symptoms. Recently I treated a patient with a typical pyæmia following a brutal delivery. Streptococci were demonstrated, both in the blood and uterine lochia, and several superficial abscesses developed. Later pulmonary symptoms appeared, and for a time it was thought that we had to deal with a metastatic process, until the demonstration of tubercle bacilli in the sputum cleared up all doubt.

Therefore, in making a diagnosis of any affection complicating the puerperium, an accurate and complete physical examination of the patient is necessary, and it should be combined with all the aids which the recent advances in microscopy and bacteriology have placed at our command.

As has already been stated, the most common form of puerperal infection is endometritis, either of the putrid or septic variety, and it is a matter of the greatest possible importance to decide with which

one has to deal. In many cases the clinical symptoms will be of great value, but it is only by taking cultures from the interior of the uterus that a positive diagnosis can be made.

Such cultures may be taken with comparatively little difficulty by means of the lochial tube, which was first introduced by Doederlein,[1] and consists of a glass tube 20 to 25 cm. in length and 3 to 4 mm. in diameter, with a slight bend at one end so as to conform to the anteflexed condition of the uterus. It is sterilized either by dry heat or boiling and is then ready for introduction. In practice, the most convenient method for its sterilization and transportation is to place it in a long test-tube of thick glass, which contains at its lower extremity a small amount of cotton, and whose upper end is plugged, just as an ordinary culture-tube.

When cultures are to be taken, all instruments are carefully sterilized by boiling and the hands and external genitalia thoroughly disinfected. The patient is placed in the dorsal or Sims position, as may be most convenient, and, after introducing a suitable speculum, the cervix is brought down as far as possible by means of a volsellum forceps and the region of the external os carefully wiped off with a bit of sterile cotton. The lochial tube is then removed from its container and introduced as far up as possible into the uterus, being careful to avoid contact with the external genitalia. A sample of lochia is then drawn up into the tube, either by aspiration with a syringe, as recommended by Doederlein, or by means of the simple device of Little,[2] which consists in threading the tube with a piece of strong silk thread, to one end of which a folded rubber band is attached to serve as a plunger, while traction is made upon the extremity of the thread which protrudes from the free end of the tube.

After aspirating the necessary quantity of lochia the tube is removed from the uterus, and after sealing its ends with sealing wax it is replaced in its container and taken to the laboratory. There it is broken in its middle portion by means of a file and cover-slips and cultures made from its contents. Fig. 397 shows the lochial tube in its container, Fig. 398 the tube fitted with a thread and rubber band, and Fig. 399 the tube sealed and ready for transport to the laboratory. While this method is somewhat complicated, it can readily be carried out by any one conversant with the ordinary rules of surgical technique and within reach of a bacteriological laboratory. If the cultures are promptly made, one can know within twenty-four hours whether one has to deal with a streptococcus infection, while another twenty-four hours will usually suffice for the identification of other bacteria.

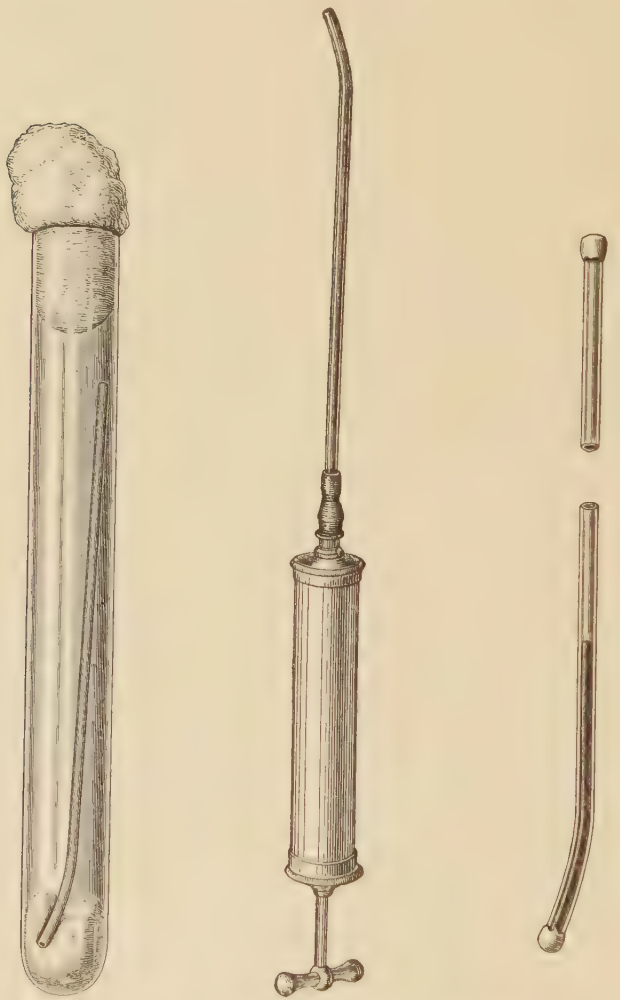
Bacteriological examination of the lochia affords the only means of positively distinguishing between the several varieties of infection, and is not only of scientific interest, but of the greatest practical importance in determining the prognosis of the case and affording a clue as to its proper treatment. I make it a part of the routine procedure in every case in which the temperature rises above 101.5° F.; and the satisfaction of knowing with which form of infection one has to deal amply repays

[1] Doederlein. Untersuchung über das Vorkommen von Spaltpilzen in den Lochien des Uterus und der Vagina gesunder und kranker Wochnerinnen. Arch. f. Gyn., 1887, xxxi. 412.

[2] Little, H. M. A simple method of obtaining uterine lochia for bacteriological examination, Bull. Johns Hopkins Hospital, 1904, xv. 250-251.

for the trouble taken. Thus, if streptococci are present, the condition should always be regarded as serious, while the presence of gonococci justifies a favorable prognosis as far as life is concerned. On the other hand, the recognition of colon bacilli, or the so-called putrefactive bacteria, practically removes all cause for anxiety.

FIG. 397. FIG. 398. FIG. 399.



Marmorek[1] and many others have recognized the value of this procedure and urge its employment in every case. Pinard,[2] on the other hand, scoffs at the idea of such examinations, and holds that they are beyond the scope of any except trained bacteriologists. Hirst,[3] in 1906,

[1] Marmorek. Le streptocoque et le sérum antistreptococcique. Annales de l'Inst. Pasteur, 1895, ix. 593–620.

[2] Pinard. Traitement de l'infection puérpérale. Paris, 1896.

[3] Hirst. Some problems in the diagnosis and treatment of puerperal infection. Amer. Medicine, 1906, xi. 121–123.

likewise speaks lightly of their value, and holds that in many cases negative results may be obtained, while bacteria may be cultivated from the blood. He, therefore, lays great stress upon the necessity of blood cultures.

In my experience, however, positive results can always be obtained if the lochia are examined prior to the tenth day of the puerperium. After that period, however, especially in certain cases of pyæmia, it must be admitted that the results are sometimes negative. On the other hand, if reliance is placed solely upon blood cultures, practically all the mild infections and not a few of the severe cases would escape differentiation, as I have upon several occasions seen women die of infection, and yet repeated blood cultures were sterile. In my opinion, therefore, the bacteriological examination of the blood is of secondary value from a diagnostic point of view. At the same time, it frequently affords valuable information, and the demonstration of streptococci always renders the prognosis ominous; although their presence in the blood by no means necessarily indicates a fatal termination, as I have repeatedly seen such cases recover, and in some instances they appeared to be but slightly sick.

Just after removing the lochial tube, it is the writer's practice, provided the cervix is sufficiently patulous, to introduce a sterile finger into the uterus and feel its interior, after which a douche of several litres of normal salt solution should be given. This procedure gives very important information as to the line of treatment to be pursued, and has enabled me in many cases to predict the result of the bacteriological examination.

In the vast majority of cases of putrid endometritis, as well as those due to the colon bacillus, the surface of the uterus is usually rough and covered by shreds of broken-down tissue; while in the septic variety, especially when due to virulent streptococci, it is frequently perfectly smooth.

The mere inspection of the lochial discharge is also of considerable value, for in putrid endometritis it is frothy and frequently very offensive in odor, while in pure streptococcus infection it is frequently very little changed from the normal. This distinction is of importance, because the first question which the practitioner usually asks of the nurse, in the presence of fever in the puerperium, is whether the lochia are foul-smelling or not, and, if the answer is negative, he feels fairly sure that the fever is of other than uterine origin; whereas almost the reverse is true, and, as a rule, the fouler the odor, the less is the danger to the patient, and *vice versa*.

When the process has extended beyond the uterus the diagnosis is much more readily made, and, with the exception of malaria, typhoid, and acute miliary tuberculosis, it is scarcely possible to mistake the symptoms produced by a peritonitis or by a pyæmia. In the cases of parametritis and suppurative affections of the tubes and ovaries, vaginal examination will demonstrate the presence of a tumor mass on one or the other side of the uterus, if it has not already made itself evident to abdominal palpation.

Treatment. PREVENTIVE. In considering the treatment of puerperal fever, prophylaxis should occupy the most important place. As has been repeatedly pointed out in the course of this article, puerperal infec-

tion is wound-infection, and is due to the introduction of pathogenic micro-organisms by the hands or instruments of the doctor or nurse. Therefore the most scrupulous asepsis during the conduct of labor is the means upon which we have to rely to limit its occurrence. Every physician who conducts a labor case should strongly feel his personal responsibility in this connection, and he does not do his full duty to his patient unless he regards the rules of asepsis as carefully as when performing a capital surgical operation.

The first point, therefore, in the prophylaxis of puerperal infection is the consideration of the preparation of the patient and the disinfection of the hands and instruments of the accoucheur as well as the recognition that every vaginal examination is a source of danger.

At the onset of labor the patient should receive a full bath and a rectal enema. Before each vaginal examination the external genitals, and especially the region about the perineum and anus, should be most scrupulously washed with soap and hot water, and then rinsed in 1 : 1000 bichloride solution, after which a pledget of absorbent cotton or a towel soaked in the same solution should be placed over the vulva and allowed to remain for at least three minutes prior to the examination. If the pubic hairs are abundant or long they should be clipped or shaved.

When operative procedures are to be undertaken the buttocks and legs of the patient should be covered with sterile dressings so as to leave exposed only the immediate field of operation, in order to reduce as far as possible the danger of contaminating the hands by organisms adhering to the bedclothes or clothing.

Hand-disinfection has long been a matter of dispute and investigators are not yet agreed as to the most practicable means of rendering the hands sterile. It may, however, be definitely stated that any reliable method will require at least ten minutes.

The rapid method of Fürbringer,[1] by which it was stated the hands could be rendered absolutely sterile in three minutes, has been shown by later experiments to be absolutely inefficient. Likewise the rapid method by means of alcohol, which was introduced by Reinicke[2] in Zweifel's clinic in Leipzig, has been shown, by the careful work of Menge and Krönig, to be based upon a fallacy, as they demonstrated that the alcohol did not possess a markedly germicidal action, but simply produced conditions in the skin which for the time being rendered it difficult to remove the organisms from its surface.

At the present time the best method of hand-disinfection with which the writer is familiar is that introduced by Dr. Halsted at the Johns Hopkins Hospital some years ago and described by Dr. Kelly.[3] Bacteriological examination shows that it is capable of yielding better results than any other method, though in a considerable number of cases it fails to render the hands absolutely sterile. The following directions are posted over every wash-basin in the lying-in ward of the Johns Hopkins Hospital:

1. Cut the finger-nails with scissors or clippers to 1 mm. in length.

[1] Fürbringer. Untersuchungen und Vorschriften über die Desinfection der Hände des Arztes nebst Bemerkungen über den bakteriologischen Charakter des Nagelschmutzes. Wiesbaden, 1888.
[2] Reinicke. Bakteriologische Untersuchungen über die Desinfection der Hände. Arch. f. Gyn., 1895, xlix. 515-558.
[3] Kelly. Hand Disinfection. Amer. Jour. Obst., 1891, xxiv. No. 12.

2. Scrub the hands and forearms up to the elbows vigorously with nail-brush, green soap, and hot water for at least five minutes by the clock, or until they are macroscopically clean, paying especial attention to the nails and palmar surface of fingers. The water must be changed at least once. After changing it, remove dirt from beneath the nails with nail cleaner or pen-knife, and then renew the washing.

3. Rinse the hands in fresh water, then soak in a hot saturated solution of potassium permanganate until they take on a deep mahogany brown.

4. Dissolve this off in a hot saturated solution of oxalic acid.

5. Then soak the hands and forearms in a 1 : 1000 bichloride solution for three minutes by the clock.

6. Touch nothing until ready to examine the patient, going directly from the bichloride solution to her.

The only objections which can be made to this method are the length of time which it requires and the roughness of the hands which is sometimes produced by it. The first objection cannot be overcome, as the writer does not believe that thorough disinfection can be effected by any method in less than ten minutes. The second can be obviated to a considerable extent by anointing the hands with a glycerin ointment after the examination is made. As even the most rigorous methods of disinfection do not render the hands absolutely sterile, it has been suggested that this object may be attained by the use of thin rubber gloves, which are thoroughly boiled before being drawn over the disinfected hands. As long as they remain intact it is impossible for any bacteria which remain to lead to infection of the patient, and their routine employment cannot be recommended too strongly. It has been objected that their use seriously interferes with the sense of touch, but in my experience this is readily overcome by practice. In any event they should always be worn when the hands have recently come in contract with pus or infectious secretions.

As long as vaginal examinations are made, no matter how carefully the hands are disinfected, infection will occasionally occur. This is due partly to the fact that hand-disinfection is much more difficult than is generally believed, and partly to the unwitting contamination of the hands before making the examination. Moreover, in many cases, even when gloves are used, bacteria may be carried from the vulva into the vagina by the examining finger, as was clearly shown by my experiments mentioned when considering auto-infection.

Therefore vaginal examinations should be restricted in number as much as possible, and if the accoucheur is acquainted with the methods of external examination, only one or at most two will be necessary in normal cases. In most cases labor can be conducted with absolute safety and ease by means of external manipulations alone. The writer believes that the only value of the vaginal examination during labor is to ascertain the degree of dilation of the cervix and to estimate the probable duration of labor, as all other points upon which we seek information can be made out far more clearly by palpation, and were I personally limited to one variety of exploration, I should have no hesitation in choosing the abdominal.

The articles of Leopold and Spörling and Leopold and Orb show the extreme accuracy of this method, and they state from their own experi-

ence that it is possible to deliver at least 90 per cent. of all cases solely by its means. Their observations show that the number of errors in diagnosis become more and more infrequent as the obstetrician becomes better trained in its technique; for example, in their first 1000 cases there were 6.5 per cent. of errors, as compared with 1.77 per cent. in the last 1000 cases.

This clearly shows what can be accomplished by external examination alone, and its importance cannot be too strongly urged upon the accoucheur. It is perfectly harmless, cannot offend the sense of modesty of the patient, and can be employed as often as desired, and, unlike digital examination, does not require laborious hand-disinfection. Abdominal palpation should always be employed to the exclusion of the vaginal examination whenever the appearance of the vaginal secretion leads one to suppose that it contains pathogenic micro-organisms. Still more important is its employment in cases where the accoucheur is not sure of the cleanliness of his own hands, as after intra-uterine manipulations in infected cases and the performance of autopsies. Under such circumstances vaginal examinations should be made only with the gloved hand.

In view of what has already been stated concerning the bacterial contents of the vagina and the result of experiments by Leopold[1] and others with the prophylactic vaginal douche, as well as from his own personal experience, the writer strongly advises that the latter be not employed as a matter of routine, and resorted to only when the vaginal secretion presents marked evidences of abnormality.

All that has been said concerning the necessity of cleanliness and asepsis on the part of the physician applies equally well to the nurse, and she should be strictly forbidden to make vaginal examinations or give douches except at the direct request of the physician in charge; otherwise one has no means of knowing, in case infection ensues, whether it is the result of one's own carelessness or not.

During labor it is well to have the vulva covered by an aseptic pad, in the form of a towel soaked in bichloride solution. This is done not so much for fear of infection from the air as to prevent the possibility of the patient contaminating herself with her own hands.

The third stage of labor likewise offers many facilities for infection, and too much stress cannot be laid upon its proper conduct. Generally speaking, the generative tract, after the birth of the child, should be regarded as a *noli me tangere*, except in cases of urgent necessity.

Excepting severe hemorrhage and cases of adherent placenta, there is absolutely no indication for introducing the hand into the recently delivered uterus. Moreover, I believe that the frequency of the latter condition is very grossly over-estimated, and in many cases its occurrence is due to the injudicious employment of Credé's method. The writer's practice is to watch the fundus of the uterus by placing his hand gently upon it, but not kneading it. After the lapse of ten or fifteen minutes, as a rule, the fundus rises about 5 cm. toward the umbilicus; which indicates that the placenta has become detached from the uterine wall and been expelled either into the lower uterine segment or into the vagina.

[1] Leopold. Vergleichende Untersuchungen über die Entbehrlichkeit der Scheidenausspülungen bei ganz normalen Geburten und über die sogenannte Selbstinfektion. Arch. f. Gyn., 1894, xlvii. 580–635.

Under such circumstances it is ready for expression, the body of the uterus being simply used as a piston to force the detached placenta through the vagina.

If after waiting half an hour the fundus does not rise up, as described, we should then resort to the typical Credé method of expression. Observance of these directions will show that adherent placenta is of very rare occurrence indeed, and will not necessitate the introduction of the hand *in utero* more than once in several hundred cases.

The practice of routine vaginal examination at the conclusion of the third stage of labor, in order to detect cervical tears, as recommended by Grandin, Dudley, and others, cannot be too strongly deprecated, and can only lead to bad results.

Another point in prophylaxis is attention to perineal lacerations, and every tear which extends deeper than the mucosa should be sutured immediately after the conclusion of labor, unless contraindicated by the general condition of the patient or by a very œdematous condition of the parts. To save time, it is the writer s practice to introduce the sutures immediately after the birth of the child and while waiting for the expulsion of the placenta. Their ends are then grasped by artery forceps, but are not tied until the placenta has been expelled. This method, beside saving considerable time, is also beneficial in that it gives one something to do during the third stage of labor and does away in great part with the temptation toward premature expression of the placenta.

After the third stage is ended, the patient should be cleaned and dressed with an aseptic vulval pad, held in place by a T-bandage.

During the puerperium the external generative organs should be frequently cleansed with a $\frac{1}{2000}$ or $\frac{1}{4000}$ bichloride solution applied by means of an irrigator or on small pieces of cotton. The writer strongly deprecates the routine use of douches during this period, and considers that they should be given only under exceptional circumstances, and then by the doctor himself, unless he has a nurse who is thoroughly versed in aseptic technique, and upon whom he feels he can confidently rely. In several cases the writer has seen infection in the later periods of the puerperium follow the use of dirty syringes in the hands of a nurse.

Curative. There still exists a great deal of dispute and uncertainty concerning the curative treatment of puerperal infection, and it is probable that what is here advocated may be directly opposed to the usual practice of many physicians. If a puerperal ulcer is present upon the the perineum or lower portion of the vagina, the parts should be kept as clean as possible, and the ulcer occasionally touched with 50 per cent. carbolic acid or tincture of iodine. If the perineum has been repaired and its edges are suppurating, the stitches should be removed, so as to facilitate free drainage.

Puerperal endometritis is the affection which is most frequently encountered, and it is here that the directions for treatment differ so greatly.

As soon as the patient's temperature reaches 102° F., unless uterine infection can be excluded with a fair degree of certainty, the uterine lochia should be examined bacteriologically. After withdrawing the tube the sterilized index-finger should be introduced into the uterine

cavity, if possible, and its interior carefully palpated; following which a careful bimanual examination should be made to ascertain the condition of the appendages and broad ligaments. If the uterine cavity is found to be perfectly smooth and not covered with shreds of broken-down tissues, a douche of several litres of boiled water or normal salt solution should be given, but curettage should not be thought of. On the other hand, if the interior of the uterus is rough and jagged and contains more or less débris, it should be thoroughly cleaned out with the finger, after which the saline douche should be employed.

The employment of the curette is not to be recommended, for the reason that in the most severe cases there is usually absolutely nothing to be removed by it, and it can only do harm by breaking down the leucocytic wall which is intended to prevent the ingress of organisms into the deeper layers of the uterus.

Its routine employment was formerly advocated by most French and American writers in all cases of puerperal infection. At present, however, its use is less general, and has been abandoned by many of its former advocates. Thus, Pinard,[1] who warmly recommended it in 1896, now considers it dangerous and worse than valueless. Unfortunately, all authorities do not share his views, and Doléris,[2] in 1905, was as radical in its advocacy as in his earlier writings. The Germans, on the other hand, have been much more conservative in this regard, and limit the use of the curette to exceptional cases. Personally, I feel that it is a very dangerous instrument, and am convinced that its employment has frequently brought about fatal results in many cases which would otherwise have recovered without treatment.

It will be noticed that nothing has been said concerning the use of douches of mercuric bichloride in the treatment of puerperal endometritis, as I consider that they are productive of more harm than good and should be abandoned. In septic endometritis they are perfectly useless; for, if the infection is virulent, the streptococci have penetrated so deeply into the uterine wall by the time serious symptoms appear as to be beyond the reach of the antiseptic.

Bumm has shown that the streptococci invade the tissues with great rapidity, and in animal experiments can traverse a distance of 2 cm. or more in six hours. Moreover, he demonstrated the very slight extent to which bichloride solutions penetrate the tissues. For this purpose he soaked the liver of an animal dead of anthrax in a 1 : 1000 solution for 30 minutes, and then cut thick sections from it by means of a freezing microtome. These were inoculated into animals, who died from anthrax as soon as sections $\frac{1}{10}$ mm. below the free surface were employed, thereby showing how little penetration had occurred.

If this be the case in the laboratory where the tissues can be soaked in bichloride for some time, what effect upon organisms lying in the muscle wall of the uterus can be expected from the passage of a few litres of bichloride solution through its cavity?

Likewise, in cases of putrid endometritis their employment is even less rational. In the vast majority of such cases simply cleaning out the uterus with the finger will lead to a rapid fall of temperature and

[1] Pinard. Comptes rend. de la soc. d'obst. de gyn. et de paed. de Paris, 1905, vii. 101–107.
[2] Doléris. Traitment intégral de l'infection puérpérale. Comptes rend. de la soc. d'obst. de gyn. et de paed. de Paris, 1905, vii. 226–253.

the amelioration of symptoms. The object in giving douches in these cases is simply to wash away débris which has been left behind by the finger, and for this purpose sterile water is far superior to any antiseptic fluid.

In addition to these somewhat theoretical objections to the employment of antiseptics in the treatment of these affections, there is the very practical one that they are far from harmless. Everyone who is conversant with the literature on the subject will recall the cases of sudden collapse following the use of intra-uterine douches of carbolic acid, while the employment of bichloride douches is sometimes the direct cause of death. Several years ago, at autopsy upon a woman supposed to have died from puerperal sepsis, I found all the anatomical lesions of bichloride poisoning, and it was at least doubtful whether the infection or the treatment instituted for its relief had caused death.

Upon looking over the literature at that time I collected some 46 cases in which death had followed the employment of bichloride douches during the puerperium. In many instances death was clearly due to the employment of excessive quantities of bichloride; but in several instances a single injection of $\frac{1}{4000}$ solution resulted in fatal mercurial poisoning.

When these facts are taken into consideration, along with the theoretical objections to the employment of antiseptics, it would appear that the benefit to be expected from their employment is at least very problematical, while the dangers are very real.

The same considerations likewise apply to the various other antiseptic agents which have been recommended from time to time. Nor am I inclined to place great confidence in the disinfectant properties of injections of alcohol, as recommended by Wetherill,[1] Sitsinsky,[2] and others. At the same time it must be admitted that the uniform success obtained by the latter in 246 cases of infection speaks in its favor; although the absence of bacteriological data somewhat weakens his case.

The results following the method of treatment just outlined are at least quite as good as those obtained by the use of the curette or antiseptic douches, and this contention is sustained by the experience of Bumm and Krönig. I have treated 92 cases of streptococcus infection by this means with 14 deaths (15 per cent.); having to do with pure cultures in 61 and mixed cultures in 31 instances. After deducting 5 cases from the former and 4 from the latter group, in all of which the patients were admitted profoundly infected, suffering from general peritonitis or pyæmia and manifestly beyond hope of recovery, there were only 5 deaths in 83 cases, a mortality of 6 per cent.

Of the 56 cases with pure streptococcus infection, 2 died, as compared with 3 in the 27 cases of mixed infection, a mortality of 3.5 and 11 per cent. respectively. These figures apparently bear out the contention of Bar and Tissier that combined infections with the streptococcus and colon bacillus are much more serious than those due to either organism alone.

At the same time, it is not desired to give the impression that pure

[1] Wetherill. The rational treatment of puerperal infection. Amer. Jour. Obst., 1903, xlvii. 590–598.

[2] Sitsinsky. Die Behandlung des septischen Wochenbetterkrankungen Ergänzungsheft. Monatschr. f. Geb. u. Gyn., 1904, xx. 640–677.

streptococcic infections are not dangerous, as I believe that the favorable results just reported can be attributed only to the fact that in my series are included many mild cases which would have escaped detection except for the routine bacteriological examination of the lochia in all febrile cases. Nevertheless, the results obtained would appear to indicate that too energetic treatment may be harmful, and that an equally good or better outcome will follow safer and more conservative measures.

To recapitulate, in puerperal endometritis, after having removed a sample of lochia for bacteriological examination, the interior of the uterus should be explored by the sterile finger, cleaned out or not, according to its condition, and douched with several litres of boiled water or sterile salt solution. If bacteriological examination shows the presence of streptococci one should at once desist from further local treatment. On the other hand, in putrid endometritis, if the symptoms do not yield to the first injection, still other injections may be resorted to. Moreover, if the infection has extended beyond the uterus, local treatment should not be persisted in, as it will prove perfectly useless and may do harm.

Bumm pointed out in his article on puerperal endometritis that in many instances the uterus had undergone very imperfect involution, and accordingly recommended the administration of ergot to secure better contraction and thereby occlude to a greater or less degree the lymphatics in the uterine wall. My own experience confirms his statement, and I can earnestly recommend the employment of the drug whenever the uterus is larger than it should be at a given period of the puerperium.

If the method of treatment just outlined does not lead to amelioration in the condition of the patient, all local treatment should be desisted from, and reliance placed upon the administration of tonics, particularly strychnine and alcohol, and it has been shown by Runge that women in this condition can bear much larger quantities of the latter than when in health. At the same time she should be given as large quantities as possible of easily digestible food. High fever should not be treated with antipyretics, though, if necessary, it may be combated by the local application of cold, either in the form of sponges or cold baths. Such measures have been enthusiastically advocated by Macé,[1] Runge,[2] and Desternes.[3] If the process has extended beyond the uterus and given rise to parametritis or pelvic peritonitis, the application of heat to the lower portion of the abdomen, in the form of poultices or other hot applications, is to be recommended.

Occasionally surprisingly good results are obtained in profound septic conditions by the repeated subcutaneous injection of sterile salt solution. Attention was first directed to this means of treatment by Bose,[4] and subsequent experience has in great part justified his predictions.

In gonorrheal endometritis active treatment is not required at the time, since in the vast majority of cases the slight rise of temperature which is noticed at the outset of the disease soon falls to normal, and the patients recover spontaneously or are left with a chronic endometritis,

[1] Macé. Traitement de la septicémie puerpérale par la réfrigération et en particulier par les bains froids. [illegible]

[2] Runge. Op. cit.

[3] Desternes. Indications et rôle du bain froid dans le traitement de l'infection puérpérale. Thèse de Paris, 1895.

[4] Bose. Injections de sérum artificiel dans les maladies infectieuses et les intoxications. Presse m. [illegible]

which can be treated more advantageously at a later period. At the same time it should be remembered that the affection occasionally results in peritonitis, and very exceptionally in a general infection.

Of late a great deal has been written upon the operative treatment of puerperal infection, nearly every prominent obstetrician and gynecologist in the country having made some contribution in this direction. Every one is agreed as to the advisability of opening parametritic abscesses as soon as fluctuation appears, rather than allowing them to rupture spontaneously. In many cases of parametritis on palpation a semi-fluctuation may be perceived, which may lead one to suppose that suppuration has occurred, whereas upon opening the supposed abscess through the vagina or abdominal wall, as the case may be, the tumor is found to be a mass of inflammatory exudate without pus-formation, and only a small amount of serous fluid will escape. Under such conditions incision frequently leads to as good results as though a considerable quantity of pus had been evacuated, just as happens in ordinary cases of cellulitis in other portions of the body.

When the presence of pus tubes or ovarian abscesses can be made out upon bimanual palpation, their removal is urgently indicated, for as long as they remain the patient will continue in a septic condition. Whether such conditions should be attacked by laparotomy or puncture through the vagina will depend upon their character. If freely movable, laparotomy should be performed; while, on the other hand, if adherent and readily accessible from the vagina, vaginal puncture with subsequent packing of the abscess cavity with gauze is to be preferred.

The chief point of discussion concerning the operative treatment of puerperal infection has been as to the advisability of removing the infected uterus at an early period. Here the various surgeons take diametrically opposite views, the more radical advocating its early removal, while the more conservative do not regard it with great favor.

It would appear to me that in the vast majority of cases hysterectomy is not indicated in the early stages of puerperal infection for two reasons: In the first place, if one operates at a period sufficiently early to prevent the extension of the process to other organs, a large number of uteri will undoubtedly be removed unnecessarily; on the other hand, if one waits until a later period, when other organs have become implicated, the operation will be useless. The plea advanced by some surgeons that the uterus should be removed in apparently desperate cases, merely in the blind hope that it may be beneficial, cannot be reprehended too strongly.

Nevertheless there is a restricted field for hysterectomy in certain rare cases—such as an adherent placenta which cannot be removed by other means, the presence of infected or necrotic myomata, or the formation of abscesses in the uterine wall. Very exceptionally, in putrid endometritis, when all efforts to check the disease have proved futile, the operation may likewise be justifiable, and was successfully performed by Sippel in one instance. Lusk, in 1896, suggested that hysterectomy might likewise be indicated in the cases of pyæmia in which infected thrombi are being carried from the uterus to other parts of the body and giving rise to a hectic condition. In the vast majority of such cases, however, the thrombi have extended into the pelvic vessels, far beyond

the borders of the uterus, so that its removal would not necessarily check the process. Much more practical is the suggestion of Freund,[1] Trendelenburg,[2] and Bumm,[3] that the thrombosed vessels be exposed by laparotomy, and excised or ligated distal to the thrombus, as may seem most expedient, just as has been done for some time in the case of infected thrombi complicating mastoid disease. Both Bumm and Trendelenburg have reported successful operations of this character, and in several cases of my own the outcome was most satisfactory.

Until very recently the development of general peritonitis was considered almost necessarily fatal, and in such cases treatment was usually perfunctory. But in the past few years Sourdille,[4] Kownatski,[5] Leopold,[6] and others have shown that recovery may occasionally follow after freely opening and draining the abdominal cavity. Cragin,[7] on the other hand, reports that his results were not encouraging. In view, however, of the almost certainly fatal outcome of expectant treatment, such interference would seem justifiable in appropriate cases, at least until more extended experience has demonstrated its value.

In certain cases of infection following criminal abortion, Pryor,[8] Robb,[9] Sourdille, and others have reported encouraging results following wide incision of the posterior fornix, and packing Douglas' cul de sac with gauze. In many such cases serous or purulent fluid escapes from the incision, so that it would appear that such a procedure may be of value in preventing a pelvic peritonitis from becoming generalized. In my limited experience this procedure has not appeared to exert an appreciable influence upon the course of the disease, but in view of the high standing of its sponsors it is worthy of trial.

The prospects of coping more successfully with puerperal infection were greatly brightened in 1895 by Marmorek's[10] announcement that he had discovered an antistreptococcic serum. In February of that year he stated before the Biological Society of Paris that he was able, by growing streptococci in a mixture of human blood serum and agar and repeatedly inoculating animals, to increase their virulence to such an extent that the one-hundred-billionth part of a cubic centimeter of the culture would kill a rabbit in thirty hours. By injecting this into animals he was able to produce what he considered a preventive and curative serum. At the same meeting Charrin and Roger[11] stated that they had likewise prepared a serum by the injection of sterile cultures of streptococci into the lower animals, and reported 2 cases of puerperal infection which they had successfully treated with it at the Paris Maternity.

[1] Freund. Ueber die Methoden und Indikationen der Totalexstirpation des Uterus. Beiträge z. Geb. u. Gyn., 1898, i. 341-401.

[2] Trendelenburg. A review of surgical progress. Jour. Amer. Med. Assn., 1906, xlvii. 81-83.

[3] Bumm. Ueber die chirurgische Behandlung des Kindbettfiebers. Samml. zwangloser Abhandlungen a. d. Gebiete der Frauenkunde u. Geb., 1902, iv. Heft 4.

[4] Sourdille. Traitement de l'infection puérpérale grave par la laparotomie ou par la colpotomie sans hysterectomie. Revue de Gyn., 1905, ix. 857-890.

[5] Kownatski. Zur Behandlung der freien puerperalen Peritonitis mit Laparotomie u. Drainage. Berliner klin. Wochenschr., 1905, No. 20.

[6] Leopold. Zur operationen Behandlung der puerperalen Peritonitis u. Pyæmie. Arch. f. Gyn., 1906, lxxvii. 1-33.

[7] Cragin. The treatment of puerperal infection. Amer. Jour. Obst., 1906, liii. 775-791.

[8] Pryor. Treatment of puerperal streptococcus infection by curettage, the cul-de-sac incision, etc. Amer. Jour. Obst., 1899, xxxix. 584-596.

[9] Robb. The vaginal incision in sepsis following abortion. Amer. Gyn., 1903, ii. 524-530.

[10] Marmorek. Sur le streptocoque. Comptes rend. de la soc. de biol., 1895, x. série, ii. 122.

[11] Charrin and Roger. Essai d'application de la sérum-therapie au treatment de la fièvre puérpérale. Comptes rend. de la soc. de biol., 1895, x. serie, ii. 234.

In July, 1895, Marmorek[1] published a long article in the *Annales de l'Institut Pasteur*, in which he described his method of preparing the serum, and gave the results of its employment in 413 cases of erysipelas and 16 cases of puerperal infection. In the latter cases bacteriological examination showed that he had to deal with pure streptococcic infection in 7 cases, all of which recovered. In the other 9 cases the streptococcus was combined with other organisms, and the results were not so favorable, as 5 ended fatally. Since then antistreptococcic serum has been largely employed in all parts of the world in the treatment of puerperal infection, but with very unsatisfactory results.

In May, 1899, a committee[2] of the American Gynecological Society, of which I was chairman, made an exhaustive report upon the subject, and collected all the cases treated by serum which had been reported up to that time. They found 352 cases, with 73 deaths, a mortality of 20.74 per cent. A large number of cases had not been examined bacteriologically; and, accordingly, there was considerable doubt as to whether they were due to the streptococcus; but in 101 cases in which its presence was demonstrated there were 33 deaths, a mortality of 32.69 per cent.

This was a very discouraging showing, especially when compared with the results obtained by Krönig[3] and the writer without its use. The question therefore arises: Was the high mortality attending its use due to the serum itself or to other causes? Our investigations indicated that the serum was practically harmless and therefore the poor results could not be attributed to its employment, but are susceptible of two explanations: First, that only exceptionally severe cases were treated; and second, that a large number of the cases so treated were in the hands of French observers, who had curetted the infected uterus as a matter of routine, and we have already referred to the serious effect of such a procedure. In view of these facts, the committee reported that there was no evidence as to the curative value of antistreptococcic serum; but at the same time, as it did not exert a deleterious effect upon the patient, it might be employed if the physician so desired.

These conclusions stand in marked contrast to the enthusiastic reports of many observers, and we are inclined to attribute the good results of individual practitioners to the fact that they employed the serum in only a few cases, and lost sight of the fact that most cases undergo spontaneous cure if not interfered with.

Following the report of our committee, the general consensus of opinion has been that Marmorek's serum has failed to substantiate its value and is practically useless as a therapeutic agent. Recently, the work of Aronsohn,[4] Tavel,[5] Menzer,[6] Meyer,[7] and others has directed renewed

[1] Marmorek. Le streptocoque et le sérum antistreptoccique. Annales de l'Institut Pasteur, 1895, ix. 593–620.

[2] Williams, Pryor, Fry, and Reynolds. The Value of Antistreptococcic Serum in the Treatment of Puerperal Infection. Trans. Amer. Gyn. Soc., 1899, xxiv. 80–126.

[3] Krönig. Bakteriologie des Genitalkanales der schwangeren, kreissenden u. puerperalen Frau. Leipzig, 1897.

[4] Aronsohn. Untersuchungen uber Streptokokken u. Antistreptokokkenserum. Berl. klin. Wochenschr., 1902, 979–982; 1903, 1006–1010.

[5] Tavel. Exp. u. klinisches über das polyvalente Antistreptokokkenserum. Deutsche med. Wochenschr., 1903, No. 50.

[6] Menzer. Das Antistreptokokkenserum und seine Anwendung beim Menschen. Münchener med. Wochenschr., 1903, 1057–1061 and 1125–1129.

[7] Meyer. Ueber Antistreptokokkenserum. Zeitschr. f. klin. Med., 1903, l. 145–152.

attention to the subject. As the result of their investigations it has been shown that Marmorek's methods were fundamentally wrong, and, in order to produce an effective serum for use in human beings, that the streptococcus should not be passed through lower animals, but that as many strains as possible of virulent bacteria, obtained from various human sources, should be employed for immunizing the animal from which the serum was obtained. It was then shown that the serum did not act directly upon the bacteria, as is the case with antidiphtheritic and antitetanic serum, but merely gave rise to conditions which favored phagocytosis—in other words, increased the opsonic power of the blood. Moreover, experimental work has demonstrated that while the serum might possess marked prophylactic value and be able to protect an animal against inoculation with many times the ordinarily fatal dose of streptococci, it was lacking in curative properties, and at most was of value only in the initial stages of infection, being without apparent effect when the process had become fully established. At the same time it was found to exert no deleterious effect upon the patient and accordingly might be administered with impunity.

Therefore, it may be said that the prospect of cure is very slight when the serum is administered to very sick patients, though if given prior to the onset of serious symptoms to patients who have been exposed to the possibility of infection it may have some prophylactic value. Modern antistreptococcic serum has been employed in series of cases by Bumm,[1] Walthard,[2] Peham,[3] Raw,[4] and others, but does not appear to have exerted an appreciable effect upon the course of the disease, and cannot be considered of any great value as a curative agent.

That none of the methods advocated for the cure of puerperal infection are wholly satisfactory is indicated by the number of methods of treatment which have been from time to time advanced, and only a few of the more recent methods will be referred to.

Thus, Fochier[5] advocates in pyæmic cases the production of what he calls "abscès de fixation"—that is, the production of abscesses on various portions of the body by the subcutaneous injection of turpentine. He states that he has observed in numerous cases of pyæmia that the condition of the patient improved as soon as abscesses made their appearance, and that in his treatment he attempts to simulate nature. This method has found few followers, and does not give promise of any great results.

Kezmarsky,[6] in 1894, reported two cases of severe venous sepsis in which he had given intravenous injections of 1 to 5 mg. of sublimate. He stated that in both cases a marked effect was apparent, and that both recovered. His work was enthusiastically taken up by Rissman,[7] who likewise reported several cures from its employment, though the results obtained by others were far from satisfactory.

[1] Bumm. Ueber Serumbehandlung bei Puerperalfieber. Berl. klin. Wochenschr., 1904, No. 44.
[2] Walthard. Grundlagen zur Serotherapie des Streptokokken-puerperalfiebers. Zeitschr. f. Geb. u. Gyn., 1904, li. 400–488.
[3] Peham. Ueber Serumbehandlung bei Puerperalfieber. Archiv. f. Gyn., 1905, lxxiv. 47–69.
[4] Raw. Puerperal septicæmia with special reference to the value of antistreptococcic serum. Jour. Obst. and Gyn. Brit. Emp., 1904, v. 524–526.
[5] Fochier. Traitement de l'infection puérpérale par la provocation de phlegmons sous-cutanes Ann. de Gyn., 1892, xxvii. 356–362.
[6] Kezmarsky. Intravenöse Sublimatinjection (Bacelli) bei venöser Sepsis im Wochenbette. Cent. f. Gyn., 1894, 906.
[7] Rissmann. Intravenöse Sublimatinjectionen bei Puerperalfieber. Frauenerzt, 1895, i. 240–244.

Another method of treatment was introduced by Hofbauer,[1] in 1896, who reported several cases of puerperal sepsis in which he produced an artificial leucocytosis by the employment of nuclein. In some of his cases the temperature fell by a lysis and in others by crisis, and he believed that the artificial leucotysosis played a marked part in their cure. He made a second communication in 1903, and claims that extended observation has confirmed his original statements.

Reference need scarcely be made to the employment of intravenous injections of formalin, as advocated by Barrows [2] in 1903, as subsequent investigation has shown that their employment is not only of no value, but absolutely harmful.

A considerable literature has accumulated upon the employment of Credé's ointment, and the intravenous injection of collargol in puerperal infection. The report of Osterloh,[3] however, clearly shows that they are of but slight value, and that whenever good results follow the use of collargol or a solution of silver nitrate they should be attributed to their power of stimulating phagocytosis.

[1] Hofbauer. Zur Verwerthung einer künstlichen Leukocytose bei der Behandlung septischen Puerperalprocesse. Cent. f. Gyn., 1896, 441–449. Die Nuclein-Kochsatz Behandlung der puerperalen Sepsis. Archiv. f. Gyn., 1903, lxxviii. 359–375.

[2] Barrows. Intravenous injection of formalin solution for puerperal septicæmia. Amer. Jour. Obst., 1903, xlvii. 366.

[3] Osterloh. Beitrag zur Behandlung des Puerperalfiebers mit intravenösen Collargoleinspritzungen. Deut. Archiv. f. klin. Med., 1905, lxxxv. 227–233.

CHAPTER XXVIII.

MALFORMATIONS, INJURIES, AND DISEASES OF THE NEW-BORN CHILD.

MALFORMATIONS.

Hydrocephalus. This condition of *water on the brain* is of two varieties: One, in which the fluid is between the brain and dura mater in the arachnoid, is rare. The other, in which the fluid is in the ventricles, is the common form. The condition may be congenital (see p. 509) or it may occur after birth. It is caused by a chronic inflammation of the lining membrane of the ventricles, causing an oversecretion of fluid resembling the cerebro-spinal fluid, which distends the ventricles and produces pressure upon the brain, which is thinned at times to a mere shell. The cranial sutures and the fontanelles are wide open and bulging. The forehead is high and projecting and the face seems small and narrow. The head cannot be held up and the mental faculties are dull. Nutrition is defective and there is little hope of recovery. Nystagmus, strabismus, and inability to close the upper lids over the eyeballs are often present. Convulsions are frequent.

Recovery is rare. When the process is arrested and the child lives, it is mentally defective.

The treatment is unsatisfactory. Potassium iodide may be tried, but it is seldom of much service. Operative interference has not been often successful. Aspiration has been tried, but it is of doubtful value.

Meningocele and Encephalocele. By the the term meningocele is meant a protrusion of a part of the membranes of the brain through an opening in the skull.

By encephalocele is meant the protrusion of brain-substance and pia with no fluid in the sac. The defect is most common in the occipital bone, in any portion of which the defect may be present, from the peripheral part to the centre. If it exists in the anterior portion of the bone, it may extend to the posterior fontanelle; if in the back part, it may connect with the foramen magnum. The size of the tumor depends, of course, upon the extent of the opening in the bone. Similar defects may also be present in the naso-frontal region, and less frequently in the basilar, temporal, and parietal segments of the skull. The openings may contain meninges alone, meninges with brain matter, or the latter with fluid in the interior; in the latter event the anomaly is termed hydrencephalocele. (Compare page 509.) The tumors appear at or soon after birth.

A *meningocele* is usually small, with little tendency to increase in size. It may be more or less pedunculated. It presents fluctuation, but no pulsation, and is usually reducible.

In *encephalocele* there is distinct pulsation, and efforts at compression

will be accompanied with evidences of marked cerebral irritation. The tumor, though not large, has a wide base and is partly reducible.

A *hydrencephalocele* is apt to be large, lobulated, with sometimes a distinct pedicle. Pulsation is usually absent in the tumor, which, however, is fluctuating and mostly translucent. Compression is not apt to be successful in reducing the tumor. Sometimes there is more brain-substance in the tumor than in the cranial cavity, and the infant is then microcephalic.

Prognosis. The prognosis in hydrencephalocele is bad, as the tumor usually grows rapidly, and there may be rupture, with immediate death. In meningocele and encephalocele the prognosis is better, especially if the tumor be small.

Treatment. Treatment in these cases is of little avail, although a few cases have recovered after removal of the tumor. Puncture of the sac and withdrawal of fluid and even stimulating injections have been tried, but the results have been discouraging.

Spina Bifida. Owing to congenital failure in the development of the vertebral arch, one or more of the laminæ may be absent, with resulting protrusion of the spinal meninges. The lumbar region of the spinal column is the part usually affected. Occasionally, however, we have meningocele or encephalocele. (Fig. 354.) The tumor is round, fluctuating, and by compression the cerebro-spinal fluid can be forced back into the spinal canal. Too severe pressure, however, may produce eclampsia or other grave cerebral symptoms. The base of the tumor depends upon the size of the opening, being pedunculated if it is small, but more sessile if large. The tumor is usually covered with skin, which, however, may be absent, exposing the dura mater. If there is not much tissue covering the tumor, transudation may occur through the walls, or rupture of the sac may take place if growth is rapid. Some portion of the lower segment of the cord or the cauda-equina is apt to be imprisoned in the sac. The extent of the involvement of nerve-tissue can be measured by the paraplegia or other evidences of lesion in the spinal cord and nerves.

Gradual absorption of the fluid may occur, and the child may grow up with little inconvenience from the shrivelled tumor. This, of course, takes place only when the nerves are not involved. In most cases there is a gradual increase in the size of the tumor, with final ulceration or rupture, followed by convulsions or coma and death. The fatal ending may also come with a gradual emaciation accompanying paraplegia.

Treatment. The treatment of small tumors consists in the application of a soft compress to avoid friction and to support the parts. When the tumor is growing, however, more energetic measures may be tried. The simplest procedure is to withdraw the fluid by aspiration, and follow this with gentle but constant pressure. The fluid must be slowly and cautiously removed, for fear of active nervous disturbance and even eclampsia. Injections with iodine of various strengths have been tried, but without much success. In some cases the tumor can be surgically removed by completely excising the sac. This may be successfully accomplished in the pedunculated variety where the opening in the lamina is small. It should never be attempted if there is evidence that the cord or cauda equina may be involved in the tumor.

Hare-lip and Cleft Palate. It sometimes happens that during fœtal development the maxillary process on one or both sides of the face fails to unite with the inter-maxillary process, leaving a space or cleft in the lip, upper maxillary bone, or even involving both the hard and soft palates. Besides the unsightly appearance of such cases, which gives the parents great concern, the deformity may prevent the infant from nursing the mother or even the bottle. It will then be necessary to feed the infant with a spoon. Great care will be needed in the management of such cases, and the physician should carefully supervise the feeding until the infant becomes old enough to admit of operative repair of the defect, which in simple hare-lip should be done at from four to six weeks after birth. In the severer forms, as in cleft palate, the time for operation will depend on the case and the judgment of the surgeon.

Congenital Umbilical Hernia into the Cord. This deformity is sometimes, though rarely, met with as a membranous sac or enlargement in the cord next to the body of the infant, containing a portion of the intestines and even a portion of the liver. Such deformity demands early operation for the return of the hernia to the abdominal cavity.

Congenital Malformation of the Heart. New-born infants sometimes exhibit a persistent blueness due to malformation of the heart. This defect usually takes the form of deficiency in the inter-auricular and inter-ventricular septa. The great vessels may likewise be involved in the malformation, especially the pulmonary artery. Dr. J. L. Smith found, in over half the cases he examined by autopsy, that the pulmonary artery was absent, rudimentary, impervious, or partially obstructed. He also found the following lesions: Right auriculo-ventricular orifice impervious or contracted; orifice of the pulmonary artery and the right auriculo-ventricular aperture impervious or contracted; right ventricle divided into two cavities by a supernumerary septum; one auricle and one ventricle; a single auriculo-ventricular opening, with inter-auricular and inter-ventricular septa incomplete; mitral orifice closed or contracted; aorta absent, rudimentary, impervious, or partially obstructed; aortic orifice and left auriculo-ventricular orifice impervious or contracted; aorta and pulmonary artery transposed, the vena cava entering the left auricle; pulmonary veins opening into the right auricle or into the vena cava or azygos veins; aorta impervious or contracted above its point of union with the ductus arteriosus; the pulmonary artery wholly or in part supplying blood to the descending aorta through the ductus arteriosus.

It is obvious that with any of these grave central lesions, not only the peripheral circulation but the nutrition as well must suffer. The blood is deficient in oxygen and has an excess of carbon dioxide. The blueness is most pronounced in the prominent parts of the face, such as the eyebrows, cheek-bones, nose, and lips. The hands and fingers are also prominently affected. The color varies from a light to a very deep purple, the discoloration being aggravated by crying or other disturbing influence.

While the infants at birth may be well developed, there are soon evidences of failure of nutrition, and they are very susceptible to intercurrent diseases. The action of the heart is rapid and tumultuous, and the respiration is correspondingly disturbed. Various bruits are heard upon auscultation of the heart. The infants suffer from lack of sufficient animal heat, and because of this and pulmonary congestion they

easily contract pneumonia. Most cases do not survive the first year, but if they live longer they present a stunted appearance, with peculiar bullous fingers and toes.

All that can be done in the way of treatment is to strive to maintain the natural temperature and a fair nutrition.

Malformation of the Rectum and Anus. Bodenhamer gives the following classification of the congenital defects of these parts: (1) Congenital narrowing of the rectum or anus without complete occlusion; (2) complete occlusion of the anus by a membranous diaphragm or well-formed skin; (3) anus absent and rectum ending in a blind pouch at a point more or less distant from the perineum; (4) anus normal in appearance, but ending in a cul-de-sac, and the rectum ending in a blind pouch at a variable distance above this point; (5) anus absent and the rectum ending in a fistula opening at any point of the perineal or sacral region; (6) the anus absent, and the rectum ending in the vagina, the bladder, or the urethra; (7) the anus and rectum normal, but the ureter, vagina, or urethra opening into the rectal cavity; (8) the rectum totally absent.

The time of the passage of the first stool and its size and character should always be investigated by the attending physician. Minor degrees of stenosis of the rectum or anus are not infrequent in the newly born. Although the thin feces of infancy may escape without difficulty, when the child grows older and the excreta become more solid, stenosis may occasion much inconvenience.

TREATMENT. Congenital stenosis is best treated by gradual dilation. A convenient bougie is the index-finger, well oiled, and daily inserted.

When a thin band of membranous tissue closes the anus, a crucial incision will open up the rectal pouch. For the graver forms of malformation, elaborate and careful operations are required, which, as they are fully treated in works on surgery, will not be considered here.

Club-foot. This deformity, usually of the equino-varus variety, is not uncommon. Its treatment should be undertaken very soon after birth. By massage, manipulation, and simple apparatus most cases can be restored to their normal shape if taken in the early weeks of life, while if left untreated for some months surgical operations and complicated apparatus will be necessary.

Hypospadias. In this deformity the urethra opens on the underside of the penis instead of continuing to the end of that organ. When the opening is far back in the perineum the scrotum may be divided into two halves, giving rise to false hermaphroditism. The treatment is purely surgical.

Epispadias. This is a rare deformity, consisting of an opening of the urethra on the dorsum of the penis. A plastic operation is the only cure.

Injuries During Birth.

Excessive Moulding. In difficult labor, even though spontaneously completed, the child not infrequently suffers more or less serious injury during its passage through the birth-canal. As the head is the part of the fœtus which normally offers the greatest resistance, it is the most frequent seat of such injuries. The soft and yielding character of the skull and the moulding to which it is frequently subjected may produce marked distortion. The diameter which falls in relation with the axis of the birth-canal is elongated at the expense of the engaging diameters.

The head, however, usually resumes its normal shape within a few days after birth.

Cephalhæmatoma is an extravasation of blood between the bone and the periosteum covering it. It usually appears within one to three days after birth. Its seat may be any portion of the cranial vault. Most commonly it occurs in the parietal region, sometimes over the temporal or occipital bones. The overlying integument presents no discoloration. A bony ring is soon developed around the base. The effusion is, in most cases, limited by a suture. The effused blood, as a rule, undergoes absorption within the first three months of life. In rare cases suppuration ensues, and even caries of the subjacent bone may occur. The fact that the tumor does not communicate with the brain cavity, which fact can usually be readily made out by palpation, serves to distinguish this affection from encephalocele.

TREATMENT. In most cases no treatment is called for. Should the tumor grow it may be strapped with adhesive plaster, the head first being shaved. Incision, while generally condemned, has been practised with success. It offers the advantage of immediate relief, and leaves no permanent deformity. The effused blood can usually be removed through a small opening. A firm compress is worn for several days to prevent refilling. It is needless to say that the strictest asepsis must be observed. If suppuration occurs the usual surgical treatment of abscess must be carried out.

Injuries to Bone and Muscles. The soft and partially developed condition of infantile bone renders it liable to injury if subjected to much mechanical violence during delivery. The cranial bones are especially liable to indentation and fracture when the forceps is employed, yet such accidents may occur in spontaneous labor. Fracture of the cranial bones is most frequently in the parietals. When the brain is not injured the fracture is not apt to result seriously. Simple indentations, apparently, vessels may lead to fatal hemorrhage. Simple indentations apparently cause little if any damage to the brain structures. Gentle efforts at reduction may be attempted, and thus the normal shape be restored. Fracture of the inferior maxillary bone may result from traction with the fingers in unskilful delivery of the after-coming head in breech presentations. Injuries may be inflicted upon the vertebræ or the spinal cord, with resulting paraplegia, and they are almost invariably fatal. Fracture of the humerus not uncommonly occurs in forcible delivery of the arm in breech births, or separation of the epiphysis from the shaft of the bone may take place. Fracture of the clavicle usually results from violent use of the fingers in extracting the after-coming head. The femur may be fractured from misdirected traction with fingers or fillet in breech delivery. Hæmatoma of the sterno-cleido-mastoid muscle may result from artificial interference in breech extractions. A hard tumor about the size of a pigeon's egg may be seen developing in this muscle, usually on its anterior border. It is noticed between the ages of one and six weeks, and usually disappears by absorption in a month or so. The muscle fibres are sometimes torn. Hæmatoma of the sterno-cleido-mastoid may lead to contracture of the injured muscle and torticollis.

Birth Palsies—Facial Paralysis. Injuries to the nerves during birth may be central or peripheral. The former injuries are, fortunately, the less frequent.

Pressure upon the seventh or facial nerve at the stylo-mastoid foramen by the blades of the forceps is usually responsible for facial paralysis. The affection is, in most cases, unilateral, and will not be noticed when the infant is at rest. When nursing or crying the palsy of the affected side is apparent. Recovery usually takes place spontaneously in a few weeks. If the paralysis does not disappear promptly, faradism may be employed. In rare cases the palsy is permanent.

Duchenne's Paralysis. The next most frequent peripheral palsy is seen in the arm. Various conditions during birth may produce compression and injury of the nerves about the shoulder, such as severe pressure of the obstetrician's finger or the blunt hook in the axilla, hæmatoma of the sterno-cleido-mastoid, or fracture of the humerus with displacement of the fragments. The greatest number of upper-arm paralyses, generally known as Erb's or Duchenne's paralysis, occur after breech deliveries. The injury usually results from traction made upon the shoulder in the delivery of the head, or in bringing down the arm when it is found above the head, or upon the head in vertex deliveries, and is due, as a rule, to

FIG. 400.

Duchenne's paralysis. (JEWETT.)[1]

stretching of the fifth, sixth, and seventh cervical nerves, although it is sometimes met with in cases of apparently normal labor. Dragging the head or the trunk strongly to one side is usually responsible for the ex-

[1] By courtesy of Dr. Wm. H. Haynes.

cessive traction upon the nerve trunks of the injured side. The deltoid, biceps, brachialis anticus, and supinator longus are the muscles oftenest affected. In mild cases the paralysis may not be noticed for some weeks, while in severe ones it will usually be apparent at once.

Diagnosis. The position of the arm is characteristic. It hangs helpless at the side and is rotated inward (Fig. 400). As the triceps is not affected, the child can extend the forearm, but cannot flex it. After a few weeks the affected muscles show more or less atrophy, but the child will generally begin to use the forearm. The diagnosis of Erb's paralysis is not, as a rule, difficult when seen during the first year. The peculiar position of the arm and the group of muscles involved are rarely met with in any other affection at this early age.

Prognosis. The prognosis will depend upon the severity of the symptoms and the time when the treatment is begun. Spontaneous recovery takes place in some cases within two or three weeks. If there is but little improvement after this length of time, spontaneous recovery is not to be expected, and the case demands active treatment. In some cases partial paralysis may remain for several years or be permanent.

Treatment should be begun as early as the third month, and should consist in frictions or massage and the persistent use of electricity. If the muscles react to the faradic current this may be used; but the galvanic current is far more effectual and to be preferred. The treatment must be continued for several months or until recovery is nearly complete. The foregoing treatment applies also in facial paralysis.

Central Paralysis. A form of meningeal hemorrhage from congestion of the vessels of the pia mater, followed by hemiplegia, is one of the results of prolonged and difficult labor. Too long delay in the application of the forceps, when the head is being subjected to prolonged pressure, is often responsible for this unfortunate accident. The careless use of ergot before delivery, by inducing a tetanic contraction of the uterus, also favors congestion of the fœtal brain.

Symptoms and Prognosis. The symptoms induced by meningeal extravasation depend, of course, upon the seat and extent of the effusion. The extravasation is frequently located over the motor convolutions, and if not extensive the hemiplegia may disappear with the absorption of the blood. If more extensive, however, the infant may be still-born or, if living, it may soon die from asphyxia or in a comatose condition. Convulsions may occur shortly after birth, followed by coma. If death does not ensue the prognosis for the extremities affected is good, as the paralysis gradually improves, often undergoing complete recovery. The brain, however, may be irreparably injured, as shown by subsequent epilepsy or even by varying degrees of idiocy.

Treatment. The treatment must be preventive. This consists in avoiding as much as possible prolonged pressure upon the fœtal head, in the judicious use of the forceps, and in seeing that the infant cries immediately after birth, thus being assured that the lungs are inflating. It is of great importance that the transition from the fœtal to the post-natal circulation should at once take place at birth, as otherwise great damage may be done, particularly to the brain; the vessels here are fragile and easily ruptured. If the infant cries the expanding lungs draw off the excess of blood that may do damage elsewhere. The physician should

give his first attention to the infant until this happens, as a short period of asphyxia may do incalculable harm. If the lungs do not act, it is well to let the cord bleed to the extent of a few drachms to prevent severe congestion of other vital organs.

Asphyxia. The accidents during labor that induce asphyxia are: Sudden death of the mother, constant pressure upon the umbilical cord, prolonged labor with severe compression of any part of the fœtal body, especially the head, as noted above, and more or less complete detachment of the placenta. In consequence of the air-hunger induced by these conditions, a vigorous infant may, by inspiratory suction, take in secretions of the birth-canal, which may cause suffocation after birth or induce pneumonia later. Very feeble infants may fail to establish respiratory move-

FIG. 401.

Byrd's method—expiration. (JEWETT.)

ments after birth, owing to weak or defective muscles and nerves. There are two varieties of asphyxia: (1) The congestive and (2) the anæmic. In the first variety there is congestion and suffusion of the skin, with blueness of the mucous membranes, full pulse, and moderate action of the reflexes. In the anæmic variety the pulse is feebler, the skin pale, and the mucous membranes assume a grayish-blue color. The reflexes are likewise lost. The prognosis in the latter condition is exceedingly bad. In the milder degrees of birth-asphyxia recovery usually ensues.

THE PREVENTIVE TREATMENT consists in measures addressed to the acceleration of tedious labors and the prevention of prolonged pressure upon the fœtal parts, especially the head. During descent of the head malpositions of the cord, especially prolapse, or winding tightly around

the neck, must be looked for, and, if possible, corrected. One of the possible causes of asphyxia will be removed if as soon as the head is born it is so turned that the face shall not lie in a pool of blood and liquor amnii. At the same time the mouth and fauces can hastily be cleaned of mucus with a moist rag drawn over the finger or by means of a soft rubber tube with a rubber bulb attached. In moderate degrees of congestive asphyxia the stimulus of the cool external air, and allowing a drachm or two of blood to escape by the cord, will be sufficient. Should this not suffice the chest may be sprinkled with cold water to stimulate the reflexes, while the infant is held suspended by the feet for the purpose of allowing mucus to gravitate from the air-passages. The child may be plunged alternately into hot and cold water, especially in anæmic cases. The hot water should have a temperature not exceeding 105° F. When these external stimuli fail to excite respiratory movements, resort must be had to artificial respiration.

FIG. 402.

Byrd's method—inspiration. (JEWETT.)

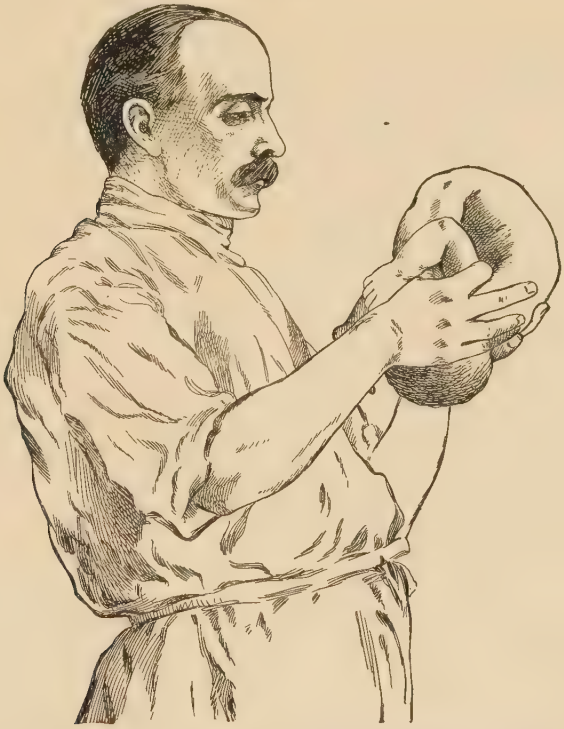
The child's pharynx should first be cleared of mucus and other liquid material that may have been drawn into it by premature efforts at respiration. The simplest and most effectual method of inflating the lungs is by direct insufflation—the mouth-to-mouth method.

DIRECT INSUFFLATION. The child is placed upon its back with the head extended by means of a small pillow or roll of clothing placed

under its neck; the mouth is well cleansed and a towel or handkerchief is spread over the face. With one hand closing the nose, and with the other making pressure upon the epigastrium, to prevent the inflation of the stomach, the physician forces air from his own gently into the child's mouth and inflates the lungs. The air is expelled by gentle pressure upon its chest, and the process then repeated. When properly performed, this method is safer than passing a catheter or other instrument into the trachea, as is sometimes practised. Care should be taken lest injury be done to the air-cells by too forcible expansion.

Byrd's Method is simple and efficient, and can be conducted without rough handling, a matter of no little importance. The child lies upon its back on the palmar surfaces of the operator's outstretched hands.

Fig. 403.



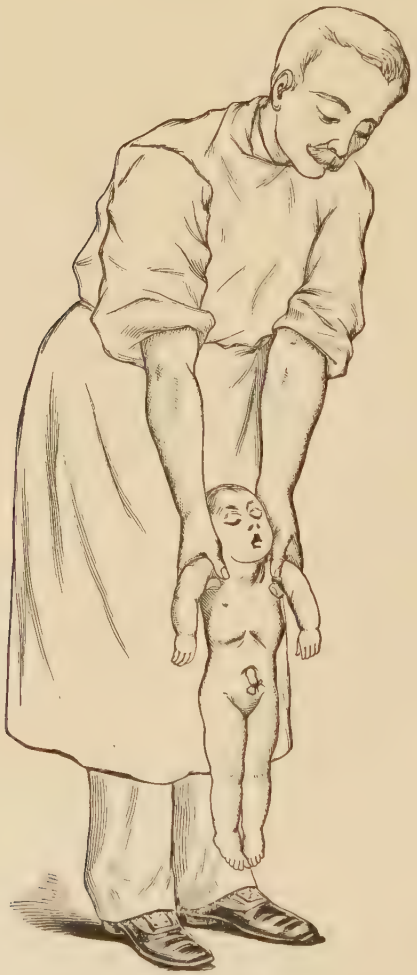
Schultze's method of artificial respiration—expiration. (Jewett.)

The operator by elevating the radial edges of his hands doubles the child's trunk upon itself—*expiration* (Fig. 401). Then by lowering the radial well below the level of the ulnar borders of the hands the child's trunk is thrown into a position of extreme extension—*inspiration* (Fig. 402).

The Method of Schultze is as follows: The operator holds the infant suspended, face to the front, his index-fingers being hooked in the axillæ, the thumbs resting on the front of the chest and the fingers upon the infant's back. The lower portion of the child's body is now swung outward, upward, and finally toward the operator's face,

inverting the position. Care should be taken that the trunk is most strongly flexed in the lumbar region. In this position the thorax is compressed—*expiration* (Fig. 403). The child's lower extremities are now swung outward away from the operator's body and downward till the child hangs suspended by its axillæ in the position first described. In this position of the child, hanging by its upper extremities, the abdominal contents fall and the diaphragm sinks—*inspiration*

FIG. 404.



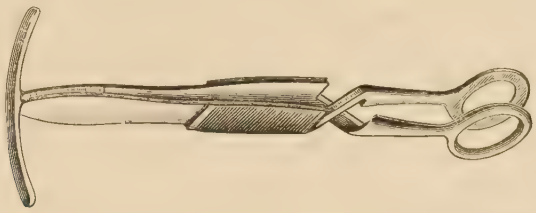
Schultze's method—inspiration. (JEWETT.)

(Fig. 404). To assist the respiratory movements the pressure of the operator's thumb is relaxed during inspiration and increased during expiration. This method is not to be recommended in feeble children.

LABORDE'S METHOD. Laborde recommends rhythmical traction upon

the tongue eight or ten times a minute as an effective method of establishing respiratory movements. It has the advantage that it can be carried on while the child is kept in the warm bath, and it does not involve rough usage.

Fig. 405.



Laborde's forceps for traction on the tongue of the new-born in the treatment of asphyxia. (After Ribemont-Dessaignes and Lepage.)

Other Measures. It must be borne in mind that it is not enough that the child begins to breathe: it must be watched for some time to see that the respirations continue. It may be advisable in some cases to administer hypodermically ten to twenty drops of whiskey combined with 1 minim of tincture of belladonna or $\frac{1}{100}$ grain of strychnine. In most cases it will be necessary after resuscitation to apply dry heat by a hot-water bag or other means. In asphyxia pallida a rectal injection of water at a temperature of 110° F. is of marked service.

Atelectasis. Closely allied to asphyxia, and often associated with it, is a persistence of the fœtal condition of the lungs, either of one or both in whole or in part. It is due to failure of the infant to completely inflate the lungs, and may persist for a considerable time. Sometimes it results in death, even after respiration had apparently been fully established.

This is more apt to involve the lower lobes than the upper ones. It is frequently seen in premature infants with feeble respiration. The cause may also be injury to the brain from pressure. The symptoms are those of deficient respiratory action, such as pallor, feeble cry, and poor circulation, with very little expansion of the chest-walls over the affected area. Deep inspiration may be encouraged by artificial respiration, and the vitality conserved by the external application of heat and the judicious administration of nourishment and stimulants.

Dead-born and Still-born Infants. Fœtal death must be distinguished from asphyxia. In the former the heart pulsations cannot be felt and respirations and reflexes are absent. In the latter the heart is pulsating, reflexes are present, and there may be feeble attempts at respiration. We should not refrain from efforts at resuscitation because the heart-sounds are absent or no pulsations can be felt in the præcordial region. The distinction between a dead-born and a still-born infant can usually be made by the rapid fall of rectal temperature in the former to ten or fifteen degrees below normal and by the widely dilated condition of the pupils in the dead-born. One or two forcible inflations of the lungs by the mouth-to-mouth method will usually cause the heart to pulsate in the still-born, while it will have no effect on the dead-born. If the heart pulsates after this trial, a hypodermic injection of whiskey, ♏ v–x, and strychnine, gr. $\frac{1}{120}$, may be given and artificial respiration continued.

DISEASES OF THE NEW-BORN.

Mastitis. The mammary glands of the new-born infant often secrete a colostrum-like substance, which appears between the fourth and tenth day after birth. During this time there may be swelling of the glands, which gradually abates with the subsidence of the secretion until, usually by the twentieth day at the latest, both secretion and swelling have disappeared. In some cases, however, if the glands be injured, or if they be unwisely squeezed by the nurse, they may remain engorged and tender and suppuration ensue. This implies infection, and is exceedingly rare when proper antiseptic precautions have been observed and meddlesome interference is avoided.

Treatment. When there is simple swelling the parts may be cleansed with soap and water and bathed with a weak antiseptic solution, either of boric acid or bichloride of mercury. Gentle support with absorbent cotton and a bandage will also be indicated. A compress kept wet with a solution of subacetate of lead (Goulard's solution) or of aluminum acetate (1 to 4 of water) may be applied. If, in spite of this, suppuration occurs, there will be rise of temperature and the local signs of abscess. Then early incision, under proper antiseptic precautions, constitutes the treatment.

Umbilical Hemorrhage. Hemorrhage may take place from the stump of the cord shortly after birth, from insecure ligation, from shrinkage, or from slipping of the ligature. Laceration of the cord between the abdomen and the ligature may also be responsible for hemorrhage. Secondary hemorrhage, usually between the fifth and fifteenth day, may occur, even though the cord has been securely ligated and properly watched. This may be due to changes in the walls of the minute bloodvessels, allowing transudation, or to imperfect coagulability of the blood. In the latter case the hypogastric artery and the umbilical artery and vein have not been tightly occluded by the usual fibrinous plug. The hemorrhage is accounted for by syphilis, jaundice, hæmophilia, or by depraved health on the part of the parents.

Treatment. Primary hemorrhage can usually be controlled by applying another ligature below the first one, by cauterizing the stump with the Paquelin cautery, or by winding the stump with styptic cotton. The great majority of cases of secondary parenchymatous bleeding are fatal, because of the impossibility of controlling the hemorrhage. In the milder ones a compress of lint tightly applied with adhesive strips may be sufficient. In more obstinate cases the lint may be saturated with a styptic, such as Monsel's solution, or with a solution of adrenalin hydrochloride. Dr. J. L. Smith recommends filling the umbilicus with a thick layer of plaster of Paris that is supported by the hand until it hardens, and then secured by a bandage. In the most obstinate bleeding the umbilicus may be transfixed with two needles placed at right angles, and a figure-of-eight ligature placed tightly around them.

Umbilical Vegetations. Fungous granulations at times appear, arising from the floor of the umbilical fossa, shortly after the falling of the cord, because of delayed healing of the umbilical wound. They may attain the size of a pea, and they usually exude a bloody serum, which may induce excoriations in the surrounding skin. The granulations may

gradually atrophy after weeks or months of sluggish existence. The constant moisture and discharge is, however, a source of irritation, and it is best to destroy the growths. This can be accomplished by repeated cauterization with the solid stick of nitrate of silver or, better, by passing a ligature around the base of the mass and amputating the exuberant granulations with scissors. A dry dressing of boric acid, powdered alum, dermatol, subnitrate of bismuth, or iodoform may then be applied.

Umbilical Hernia. An incomplete closure of the umbilical ring may result from defective development of the abdominal wall, with resulting protrusion of abdominal viscera at this point. A tendency to protrusion must be corrected at once by the constant application of pressure, or the application of strips of adhesive plaster long enough to hold the recti muscles in close apposition. These strips may be reapplied at intervals of a few days. If this is not sufficient, which is rarely the case, or if the rupture increases rapidly in size, immediate operative interference is demanded.

Icterus Neonatorum. Icterus is a common affection of the new-born. Two distinct varieties are recognized, differing widely as regards causation and prognosis, and known as the mild and the grave forms.

Mild Form. Two divergent theories have been advanced to account for this form. The first considers the jaundice to be purely hæmatic; the second theory regards it as hepatic in origin. Bile is first formed in the liver, and then carried into the circulation, the resorption being due either to congestion or to œdema of the hepatic tissue. It seems highly probable that both these theories may apply in different instances, and doubtless many cases of icterus neonatorum are to be satisfactorily explained only by taking into consideration a morbid condition of both the blood and the liver, thus combining the hæmatic and hepatic theories.

The intense congestion of the skin observed during the first few hours of life often produces a yellowish coloration that cannot be considered jaundice. It is of the same nature as the discoloration of the skin following an ordinary cutaneous bruise. The yellow tint is at first seen only on deep pressure, but as the erythema fades the yellowness increases. The conjunctivæ are not colored, and the urine appears normal. This yellowness is usually first noticed on the second day, and may continue a few days or a week.

The term "true icterus" can be applied only to those cases in which the yellow discoloration of the skin is caused by a staining by the bile pigments. This more often occurs in cases of prolonged or difficult labor, in children born asphyxiated or before term, and in generally feeble infants. It is very frequently seen in foundling asylums. It may appear as early as a few hours after birth, but usually is not marked until the second or third day. In very mild cases the yellow color may appear only on the face, chest, and back, the conjunctivæ being but faintly tinted and the urine and feces normal in appearance. In severer forms the urine may be high-colored enough to stain the linen, and the jaundiced hue may extend to the arms and abdomen. Some infants present a yellowish discoloration of the whole body, with typical clay-colored stools. In most cases the jaundice has disappeared by the eighth or tenth day. It may, however, persist for several weeks. In rare cases, after having much diminished, it reappears with renewed intensity. No

matter how extensive this form of jaundice may be, it causes very little constitutional disturbance. The liver may be slightly enlarged, and occasionally there are symptoms of intestinal catarrh. A few small doses of calomel or mercury with chalk will be all the medication required.

Grave Form. This form is, fortunately, rare, and may be produced by several different conditions. Defects in the bile-ducts will first be mentioned as among the commonest causes. In some cases all the large bile-ducts have been absent; in others the ductus communis choledochus has been narrowed, obliterated, or entirely absent. Sometimes a fibrous cord has been found in place of the gall-duct. The cystic duct has been absent and the gall-bladder in a rudimentary condition. Accompanying an obliteration of the gall-ducts cirrhosis is usually found in the liver, which will be more or less marked, according to the length of time the infant survives. The liver is generally enlarged. Jaundice that is due to obstruction or obliteration of the biliary passages may appear a few hours after birth, and soon acquire a marked intensity. It often, however, does not appear for one or two weeks after birth. The yellowish discoloration of the skin may vary from day to day, at times being much more intense than others. The conjunctivæ are yellow. The fecal discharges lose color and have an offensive odor, while the urine stains the napkin a yellow or greenish-brown. The spleen, as well as the liver, is usually enlarged, which partially accounts for the increase in size of the abdomen. Umbilical hemorrhage is a grave and not infrequent symptom in this form of jaundice. The bleeding is not sudden and profuse, but begins as an oozing shortly after the separation of the navel string. It is apt to commence at night. Death is always hastened by this accident, and exhaustion from loss of blood is added to that induced by indigestion and malassimilation. There may also be a species of general purpura, bleeding taking place from the nose, mouth, or stomach. Infants may live for several months with impervious or defective bile-ducts, though death usually takes place earlier, from failure of nutrition.

Another form of grave icterus neonatorum is observed in connection with certain inflammatory changes in the liver, usually taking the form of an interstitial hepatitis, with which may be conjoined inflammation of the biliary canals. This lesion is apt to be one of the results of congenital syphilis, as is likewise perihepatitis, which may cause a complete obliteration of the biliary passages. The latter form of inflammation often involves the connective tissue surrounding the common duct, the portal vein, and the hepatic artery on the under surface of the liver. These cases, however, may not always be of syphilitic origin. Perhaps the commonest manifestation of the grave form of icterus in the newly born is seen in connection with septic poisoning—that is, generally accompanied with phlebitis. This will be considered under the head of Sepsis.

Acute Fatty Degeneration of the New-born (Buhl's Disease). This is an affection of uncommon occurrence, first described by Buhl in 1861. The etiology is still in doubt. The pathology consists in a parenchymatous inflammation followed by a fatty degeneration of the tissues of the heart, liver, kidneys, with hemorrhages in various organs. Children afflicted by this disease are usually born in a state of severe asphyxia, many of whom die at once. When they survive, they soon suffer with

diarrhœa, vomiting of blood, and have hemorrhages under the skin, conjunctiva, from the mouth, nose, etc. They often have icterus, sometimes œdema and cyanosis. They usually die within the first fourteen days of life. Treatment is of little avail.

Infectious Hemoglobinuria (Winkel's Disease). This is a disease of endemic or epidemic character, usually occurring in hospitals. The etiology is obscure, but it is probably an infection. The symptoms somewhat closely resemble those of Buhl's disease. It begins three or four days after birth and death usually takes place in about two days. The characteristic symptoms are hæmoglobinuria, with cyanosis and icterus, occurring in epidemics. The red blood-cells become greatly reduced. The treatment recommended is the inhalations of oxygen and stimulants. The prognosis is very bad.

Hemorrhagic Diseases of the New-born. Under this heading are included spontaneous hemorrhages occurring in the first few days or weeks of life not due to hereditary hæmophilia. The hemorrhages usually occur from the gastro-intestinal tract, the mouth, nose, or as ecchymoses under the skin. They may rarely occur in the abdominal cavity, the pleura, the lungs, or in the meninges. The bleeding begins in most cases on the second or third day, although it may come on as late as the fifth day. The temperature is raised during the first day or two and the infant recovers or dies within five or six days. The disease occurs most often in lying-in hospitals, and is believed to be the result of infection, probably entering through the intestinal tract. The condition is sometimes described under the name of *Melæna neonatorum*. The *prognosis* is serious, though the disease is not necessarily fatal. The *treatment* is usually inefficient. When the hemorrhage is from the gastro-intestinal tract 1- to 2-drop doses of solution of adrenalin hydrochloride (1 : 1000) should be tried, carefully watching its systemic effect. A sterilized solution of pure gelatin in water, 1 to 2 per cent., may be given by the mouth in $\frac{1}{2}$-ounce doses every two hours. Either of these remedies may be used in external hemorrhages from the skin or umbilicus.

Umbilical Infection. The umbilicus is the most vulnerable spot for the entrance of septic poisons during or shortly after birth. Upon ligation of the cord the blood that remains in the umbilical veins forms small thrombi that should gradually harden, and in time become calcified, forming a fibrous cord in the same manner as in the ductus arteriosus and ductus venosus. In these latter structures the formation of thrombi is never accompanied with grave consequences, since their internal situation prevents the access of infectious agents. Pyogenic organisms, however, can readily gain access to the umbilical vein, and give rise to umbilical phlebitis and septicæmia.

There is a constant alteration after birth in the blood-pressure in the umbilical vein, due to the action of the heart and lungs, by which a sort of flux and reflux is produced. This favors infection of the system when the contents of this vein become septic.

This grave accident is liable to occur when the mother is in a septic condition. The poison may be produced by the same agents that have caused the puerperal fever. In these cases of sepsis there is a puriform or yellow softening of the thrombi that fill the umbilical vein.

The softened matter consists of pus-corpuscles and finely granular matter containing micrococci. This sets up an inflammation not only in the vessel itself, but also in the surrounding tissues. Infective emboli may be carried to various parts of the body. As the micrococci enter the umbilical vein from the umbilical fossa, owing to the perviousness of this vessel, the structures near at hand, especially the liver, bear the first brunt of the septic inflammation. The latter organ is usually found much diseased or degenerated. There is severe jaundice, with constant elevation of temperature and other symptoms of general septic infection. If the infant lives long enough peritonitis will probably develop, and sometimes empyema or even meningitis. In all cases evidence of severe illness and prostration are present. Cutaneous, mucous, or visceral hemorrhages may supervene at any time. The abdomen is generally swollen and tender, and dirty-looking pus may be seen oozing from the navel; slight pressure about the umbilicus will often cause pus to exude if it is not otherwise apparent. The fecal discharges may be of natural appearance, but the urine is usually highly colored. The infant refuses nourishment, and there may be vomiting of greenish matter. Severe nervous symptoms, such as convulsions or coma, supervene before death. While the umbilicus is the most common seat of septic infection, any sore or abrasion elsewhere may afford entrance to germs. Erysipelatous eruptions on the abdomen, chest, or other parts, are the most frequent manifestations of such infection.

Treatment. The prophylactic treatment of sepsis consists in the careful antiseptic management of labor and proper attention and cleanliness in reference to the navel. Localized sepsis may be combated by the topical use of peroxide of hydrogen, ichthyol, or other strong antiseptic agents.

The remedial treatment of systemic infection consists in full stimulation and general support, and the judicious use of external refrigerant measures. In the latter condition, however, treatment is generally futile.

Conjunctivitis. The conjunctival membrane in the new-born is very sensitive and frequently the seat of inflammation. A mild catarrhal inflammation is often seen, unattended by swelling of the lids, the inner surface being reddened and covered with a slight viscous secretion.

Treatment. The eyes must be kept cleansed by frequent bathing or irrigation with a saturated solution of boric acid. A little vaseline may be applied to the lids to prevent retention of the secretion by adhesion of their edges.

Ophthalmia Neonatorum. This form of purulent conjunctivitis may be due to infection by the gonococcus or by various other pyogenic cocci. If the disease manifests itself by the second or third day, the infection probably took place during birth. When there is a delay of a week or more, however, the virus has probably been conveyed by careless attendants, by soiled fingers, or other infected objects. The inflammation is of an intensely virulent type, involving both the ocular and palpebral conjunctivæ. The sac is filled with a grayish muco-purulent secretion and there is intense chemosis. The subconjunctival connective tissue and skin are much swollen, so that the eye can only with difficulty be opened. There are photophobia, pain in the eye, and rise of temperature. Unless the symptoms quickly subside, the eye is irreparably damaged

by ulceration and partial destruction of the cornea, followed by permanent disfigurement or blindness. The inflammation begins in one eye, but soon attacks the other unless it is effectively protected.

The Prophylactic Treatment consists in employing antiseptic vaginal douches in the parturient woman when there is any mucopurulent discharge, and dropping 2 or 3 drops of a 2 per cent. solution of silver nitrate into each eye immediately after birth, after the method proposed by Credé.

Curative Treatment. When the inflammation has actually begun the eye must be kept as free of pus as possible by frequent washings with a saturated solution of boric acid. The swelled and puffy lids should have applied to them every few minutes pledgets of sheet lint that have been kept upon a cake of ice, and they must be removed every hour or two. Constant cleansing and cooling of the surface will require the services of a careful nurse night and day. A 2 per cent. solution of nitrate of silver or of bichloride of mercury, 1 or 2 grains to the pint, may be instilled between the lids every two or three hours, according to the severity of the case. As this affection so frequently results in blindness, it is well, if possible, to have the advice of an oculist. Protargol or argyrol in 10 per cent. solution has been recently recommended as a substitute for nitrate of silver. These latter salts have the advantage of being less painful and are said to be equally efficient.

Tetanus Neonatorum. Although this disease is distributed through a wide geographical area, it is most apt to be found in filthy surroundings. Something beside filth, however, is necessary; there must be a specific cause. This consists in the tetanus bacillus, of the pin-head and bristle-shaped form. It may exist in straw or dust from hay, which explains the fact that horses are subject to tetanus, and that traumatic tetanus is often seen among laborers who are employed about farms and stables.

The disease usually begins during the first ten days of life, and the onset is apt to be preceded by great fretfulness. Disinclination to nurse is soon followed by rigidity of the voluntary muscles, usually starting in the masseters. The rigidity increases, reaching its maximum in from twelve to twenty-four hours. The head is thrown back, and there is a general flexion of the extremities. One peculiarity of the disease is that while the toes are flexed the great toes are adducted. There may be some relaxation at times, especially during sleep, but there are constant exacerbations, provoked by any peripheral irritation. Respiration and circulation may be extremely embarrassed, and opisthotonus may be present during these exacerbations.

Treatment. While the specific cause of the disease may gain entrance at any point of the body when the necessary lesion exists, the umbilical wound is undoubtedly the seat of infection in the great majority of cases of tetanus neonatorum; hence the utmost cleanliness must be observed in cutting the cord and in dressing it. The scissors, the ligature, and the entire management of the navel, cord, stump, and the umbilical wound must be rigidly aseptic. The excess of the gelatinous matter should be stripped from the cord, and a dry, antiseptic dressing applied. Speedy mummification of the stump is the best safeguard against infection. Special care must be exercised in the umbilical dressings where the dwelling is easy of access to stable-yards containing horse-manure or loose earth.

When the disease is once established it is almost invariably fatal. In cases of suppuration at the umbilicus, frequent cleansing with a solution of mercuric bichloride of suitable strength should be employed. With reference to drugs, the two most valuable are potassium bromide, gr. iv every two to four hours, and chloral hydrate, gr. j every hour. Sulphonal, gr. iij every two hours, by the rectum, has been recommended. While these are administered the infant must be given nourishment frequently, and stimulants should be freely employed. The difficulty of swallowing, however, is a source of embarrassment in satisfactorily carrying out these measures. A tetanus antitoxin is now produced by several manufacturing chemists, but little experience has been reported in the serum treatment of tetanus neonatorum.

Tubercular Infection. Tuberculosis is very rare in the newly born, and is not common in the first year. It has been disputed that the fœtus can be infected by tubercle bacilli in the uterus, but the evidence seems to show that such infection may occasionally, though rarely, take place. Acute miliary tuberculosis, however, may develop within the first few days of life. In very early life the lymph tracts and bones are especially liable to tubercular infection. The prominent symptoms are irregular fever, rapid wasting, and prostration. Increased frequency of respiration and bronchial râles are present, but the infants usually die from a general infiltration of all the organs with fine, miliary tubercles before they have time to localize sufficiently in any one organ to be detected by physical signs.

Sclerema Neonatorum is a rare disease, occurring in early life, and is characterized by a hardening of the skin and subcutaneous tissues, accompanied by a low temperature. Soon after birth hardened spots appear on the skin, usually on the feet or legs, which gradually coalesce, and then this spreads upward, involving the legs and trunk. The limbs become stiff, thick, and the infant is unable to move them. The infant grows weak and somnolent, refuses food, and dies from inanition. Treatment is of no avail.

Pemphigus Neonatorum. This is an infectious disease, chiefly attacking new-born infants, but is transmissible to older children and adults. It is characterized by the appearance of bullæ, mostly on the body, varying in size from one-fourth to two inches in diameter. The bullæ are filled with a clear serum, which soon becomes cloudy, and after a few days the blebs rupture, leaving a red patch which exudes serum for a short time and finally heals, leaving no scar. This is the course of the usual benign form. Some cases are so severe that they have received the name of *malignant phemphigus*, which is believed to be identical with contagious impetigo, both being caused by the *staphylococcus aureus*. It may occasionally prove fatal. The treatment consists in giving a warm soap-and-water bath twice daily, followed by an application of boric acid ointment, or dusting with dermatol and starch, 1 to 9. Large blebs may require applications of lint wet with saturated boric acid solution, or carron oil to which 1 per cent. of thymol has been added.

Syphilis. This disease may be acquired from the father or mother or from both parents, the poison being conveyed by the spermatozoa of the male or the ovum of the female. While it has been denied by some observers that the father alone can transmit syphilis, the consensus of

opinion is in favor of the possibility of such transmission. Without antisyphilitic treatment the spermatozoa can usually convey the syphilitic poison during the first year after primary infection, and there is great danger to the fœtus from syphilitic contagion up to the fourth year. The influence of the mother upon the growth and development of the fœtus contained within her uterus is obviously very great, and when she is suffering from constitutional syphilis the disease is transmitted in an active stage to her child. The degree of such transmission depends, as noted above in the case of the father, upon the stage and severity of the disease and the nature of the treatment employed. During periods of latency the mother may bear healthy children, followed by abortions or syphilitic infants caused by renewed manifestations of the disease. It has been considered that the power of transmission is practically lost at the end of six years.

Colles' Law. In 1837 Colles wrote that "A new-born child affected with inherited syphilis, even though it may have the specific lesions in the mouth, never causes infection of the breast which it sucks if it be the mother who nurses it, although continuing capable of infecting a strange nurse." The substantial truth of this dictum has not been seriously questioned, though various explanations have been offered.

When the virus of the disease is concentrated, as in cases where both parents are syphilitic, the fœtus will be attacked by the disease in the uterus, and, as a result, abortion will occur more or less early in the pregnancy. As the disease abates in one or both parents the pregnancies will be longer in duration, until, at last, apparently healthy infants may be born. In some cases the infant will present marked evidences of syphilis at birth; often, however, the onset is delayed until later, and at birth there may be absolutely no manifestation of the disease. The earlier the disease shows itself after birth the graver will be the nature of the attack.

Very early syphilis is usually accompanied by emaciation, eruptions of bullæ, particularly upon the palms of the hands and soles of the feet, and an extreme degree of coryza, cracked and ulcerated lips, and evidences of visceral and bone disease. In the older cases there may be no interference with nutrition, and possibly one or two mucous patches may be the only active evidence of the infection.

Treatment. The treatment may be local or internal. Daily inunctions of mercurial ointment mixed with from four to eight times its quantity of vaseline or rose ointment are efficacious. It may be rubbed on the inside of the thighs or in the axillæ, using a portion about the size of a hickory-nut. A more cleanly method of local medication consists in applying five drops of a 10 per cent. solution of oleate of mercury three times daily. Mercury with chalk may be internally administered, in doses of $\frac{1}{4}$ grain to 1 or 2 grains twice daily. Calomel has a more rapid action in doses of from $\frac{1}{20}$ to $\frac{1}{6}$ grain three times a day. Parents who exhibit evidence of syphilis or who have had syphilitic children should be subject to full specific treatment. A mother who is known to be syphilitic, and who has had repeated miscarriages, should be given specific treatment during her pregnancy, as a means of enabling her to bear a healthy child.

Thrush or Sprue. This is a disease liable to make its appearance

during the first or second week after the birth of an infant, especially when cleanliness of the mouth, bottle, or nipples is neglected. It is a parasitic disease, characterized by the appearance of small white patches or flakes on the tongue, inside the cheeks, or on the palate. The parasite which produces sprue is a fungus resembling the moulds. The spores are found in the air at all times, and they grow in the mouth only in a pathological condition of the epithelium, such as catarrhal inflammation. One of the fruitful causes of this disease is the rough usage the mucous membrane receives at the hands of a careless nurse, by which the epithelium is denuded or injured. The fungus belongs to the saccharomycetes or sugar-fermenting organisms. It has received the name of *saccharomyces albicans*, and was formerly known as the *oïdium albicans*. When examined with a low-power microscope, the white patches are found to consist of small threads and small oval spores. With a higher power the threads are shown to be made up of small rod-like segments connected together at the ends. From these shorter rods the spores are developed. These spores, when placed in suitable conditions, germinate and produce the thread or mycelium. They exist in the atmosphere, and when they are deposited upon a mucous membrane previously irritated or the subject of catarrh, they grow, producing the patches above described. The growth usually begins at many isolated points in the mouth, and spreads out into larger patches, which often coalesce, forming a more or less continuous crust or pseudo-membrane. Almost the whole of the tongue, cheeks, and hard palate may become covered. It may even extend to the soft palate and pharynx, but rarely into the stomach or intestines.

Symptoms and Diagnosis. The appearance of the white patches in the mouth of the infant, firmly adhering to the membrane, is sufficiently characteristic to make the diagnosis easy and certain. The mucous membrane of the mouth is usually dry. If the patches be forcibly removed, the mucous membrane beneath appears red, and will frequently bleed. When these deposits appear upon the tonsils or soft palate they may be mistaken for diphtheritic exudate, a mistake which is hardly possible if all the symptoms are taken into consideration. The disease is not in itself a dangerous one, and in many cases it should be regarded only as a symptom of debility or inanition.

Treatment. Most important is prophylaxis. Careful attention to cleanliness of the mouth, nipples, bottles, clothes, etc., will usually prevent the occurrence of sprue. The infant's mouth should be carefully and gently cleansed several times a day with some mild antiseptic solution, as boric acid or sodium salicylate slightly sweetened with glycerin.

On the first appearance of the white specks or patches in the mouth of an infant, it should be washed after each nursing with a mixture of equal parts of water, solution of hydrogen dioxide and glycerin, or a solution of sodium benzoate or sodium salicylate, 10 grains to the ounce. The popular solution of borax and honey is objectionable, since the honey feeds the ferment and causes it to grow more rapidly, while the borax is not a sufficiently active antiseptic to prevent it.

The nurse should be cautioned against using harshness in washing the mouth, lest she make it sore. No attempt must be made forcibly to detach the membrane. If the child is nursed at the breast, the

nipples should be washed with one of the above antiseptic solutions after each nursing; if artificially fed, the rubber nipples must be thoroughly disinfected after using.

Indigestion and colic are frequent complications of sprue. The passages become green and slimy and contain undigested curds and fats. The swallowed ferment leads to acid fermentation in the stomach or intestines, with the production of excessive acidity of the stools, and frequently the appearance of troublesome erythema of the nates. The gastro-intestinal disorder, as well as the primary affection, will need careful attention. With proper treatment the disease is easily managed.

Colic. This is a common affection of the new-born infant. The pain is usually the result either of flatulence or excessive acidity, due to indigestion and acid fermentation. Usually the paroxysms come on at certain hours of the day, with intervals of complete or partial freedom from pain. It is more prevalent in artificially fed infants than in those nursed at the breast. Once established in early infancy it usually continues with more or less severity for two or three months. The importance, therefore, of careful attention to the food and the feeding of infants during their first week becomes self-evident.

Intestinal fermentation, or decomposition of the food or of the intestinal mucus, with the production of gas and distension of the bowels, is almost uniformly present. This distension and the irritation of the mucous membrane by the products of the fermentation induce spasm of the muscular fibres of the intestinal walls, which is the immediate cause of the pain.

The most frequent cause of infantile colic is overfeeding during the first two or three days after birth, or feeding with improper foods.

When the infant is to be nursed by its mother, no other food should be given, unless the mother's milk is manifestly delayed or abnormally deficient. If the child is to be artificially fed, no other food should be allowed than that prescribed by the attending physician. Milk sugar, however, dissolved in water, may be given without harm. In most cases the bottle-fed infant is nursed upon the breast for the first week, unless deformed or sore nipples prevent. In beginning the artificial feeding of infants, nature's method should be followed as nearly as possible. During the first three days small quantities only should be given. The table on page 307 will serve as a guide to the quantity and frequency of meals.

The cause is occasionally to be found in some abnormality in the quality of the mother's milk, the most frequent, during the first and second weeks of lactation, being the persistence of a high percentage of proteids, which we have seen to be characteristic of colostrum. In such cases the infant's stools are usually copious, frequent, and thin in consistency, and may or may not contain undigested masses of curd. A microscopic examination of the milk will reveal the peculiar corpuscles of colostrum. Sometimes an excess of fat in the milk will cause colic. The child will usually vomit after nursing and the stools will contain an excess of fat.

Diagnosis. It must be remembered that crying is not necessarily due to colic. Often the cause is need of food. The cry of hunger is usually more constant than that of colic, which is intermittent and

paroxysmal. It is not so violent, the child rather fretting than crying, and is quieted by feeding, while the cry of colic is usually rather aggravated than relieved by feeding. The cry of colic is usually intermittent and violent, the child drawing up its knees during the paroxysms, the abdominal muscles being at the same time tense, and the abdomen usually full and tympanitic. The pain may be due to other causes than colic. There is usually, however, little difficulty in distinguishing between colic and other forms of pain. Infants who suffer with colic usually appear to be hungry most of the time and, consequently, are often overfed.

Treatment. The treatment of colic is both palliative and curative. It is doubtful if much benefit is derived from carminatives, such as anise, fennel, chamomile, gin, etc.

Better results are secured usually by enemata of warm water or by irrigations of the colon, especially when the stools are fetid. A pint of warm water or weak chamomile tea injected high up by means of a soft-rubber catheter may be used as an irrigant twice daily with great benefit. An injection of 3 or 4 ounces of warm water, with ½ ounce of glycerin, rarely fails to excite peristalsis with the expulsion of the gas.

Friction applied to the abdomen, following the course of the colon, is sometimes useful. Heat applied by means of warmed dry flannels wrapped about the body or legs, or by holding the bare feet near a warm stove, is sometimes beneficial.

The most useful drug in colic is chloral hydrate (½ to 1 gr.), dissolved in a teaspoonful of anise-water, may be given once to three times daily. It checks fermentation and quiets the nervous system without disturbing digestion. Chloroform-water (5 to 10 drops) given every hour or two is often efficient in relieving the pains. An occasional dose of castor oil (½ drachm), calomel, or syrup of senna leaves will be found useful. Milk of asafœtida (℥j by the mouth or ℥j by the rectum) is a valuable remedy.

The curative treatment must be addressed to the digestion. The most common cause of the affection in hand-fed infants is overfeeding. Next to this is feeding improper food. Great care is necessary in adapting the food to the needs and power of digestion of the new-born child. It is well to bear in mind that the most frequent cause of colic, as regards the quality of food, is an excess of sugar or casein. An excessive amount of fat may occasionally be the cause of colic. When curds appear in the stools, whey, made from whole milk, should be used as the food for a few days. The use of farinaceous foods must be prohibited. If the passages are excessively acid and the nates are erythematous, antifermentatives and antacids are indicated. Calomel in $\frac{1}{20}$-grain doses, with 1 grain each of sodium benzoate and chalk, may be given every two hours.

The stools must be carefully examined for excessive acidity, fatty acids or fat, and for undigested casein, and the food modified to suit the indications here given. White, yellowish-white, or grayish lumps in the stools may consist of fat, fatty acids, or casein. Fat and free fatty acids dissolve in ether, while casein does not.

The following paste has been found useful by the author as an

antacid and antifermentative laxative remedy in the treatment of colic attended with constipation:

Olei ricini	℥ss.
Magnesii carbonatis	ʒij.
Sodii benzoatis	℥ss.
Sacchari lactis	ʒij.
Olei anisi	gttv.—M.

Sig. Teaspoonful once or twice a day.

Strict regularity in the quantity and quality of food and frequency of feeding and scrupulous cleanliness must be insisted upon. The temperature of the food is also a matter of importance. If the food be given too hot or too cold, it may cause colic. Digestive or nervous disturbances in the mother, which may cause colic in the nursing infant, must receive attention.

PART VIII.

OBSTETRIC SURGERY.

CHAPTER XXIX.

IMMEDIATE REPAIR OF VAGINAL AND VULVAR LACERATIONS AND OF THE LACERATED CERVIX.

IMMEDIATE REPAIR OF VAGINAL AND VULVAR LACERATIONS.

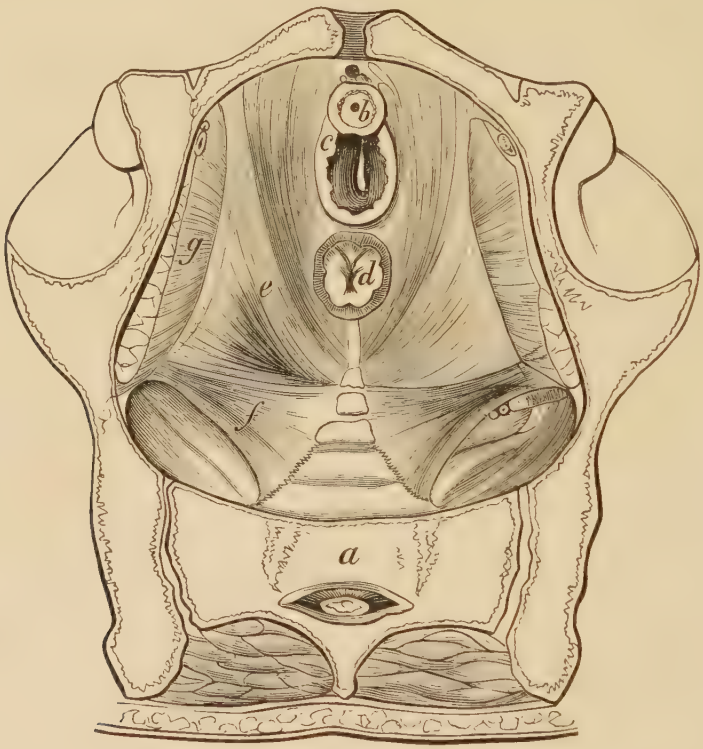
WITHOUT a thorough knowledge of the anatomy and physiology of the structures concerned, it is impossible to arrive at a scientific method of treating the various injuries to which the vaginal outlet is subjected. It must be remembered that the normal outlet of the vagina is not a gaping orifice, but in the virgin, as she stands erect, appears externally as a mere slit, lying immediately under the vestibule beneath the pelvic arch. In a woman who has born children the outlet may be slightly relaxed without producing any serious consequences, but all marked grades of relaxation must be regarded as pathological. It was formerly thought that the wedge of tissue represented by the perineal body, like the keystone of an arch, formed the main support of the pelvic contents. As a matter of fact, the perineal body in itself has very little to do with keeping the organs in position. Again, it has been recently demonstrated that the levator ani muscle can hardly possess the functions assigned to it in this connection, but that the all-important structures are the fascial sheets of the pelvic floor.

On inspection it will be noticed that both the vaginal outlet and the anus are situated well forward, the former being under the pubic arch. The index finger, when introduced into the vagina, will feel the pubic arch above and to the sides, while as it is passed backward it impinges upon a resilient band of tissue stretching across the floor of the pelvic outlet from one pubic ramus to the other. By making continued firm pressure upon the posterior wall of the vagina a marked relaxation of this band is produced, together with a definite descent of the pelvic floor, which recovers its former position as soon as the pressure is removed.

The recent work of Browning has shown that the levator ani muscle, from its insertion into the perineal body, the external sphincter ani, the postrectal raphe and the coccyx, pulls forward and upward the post-vaginal structures of the pelvic floor. But the same author has shown that in a case examined by him shortly after the expulsion of an eight months' fœtus there was no evidence of stretching of the fibres of this muscle. Again, he argues that it is unphysiologic for a muscle to furnish a continuous support. The recto-vesical fascia lies above

the levator ani and sends processes to the bladder, vagina, and rectum. Browning denies that this latter structure is merely a part of the sheath of the muscle, and is of the opinion that, when intact, it is sufficient by

FIG. 406.



Dissection of pelvis, from above. (SAVAGE.)
a. sacrum. *b*. urethra. *c*. vagina. *d*. rectum. *e*. levator ani. *f*. coccygeus. *g*. obturator internus.

itself to afford all the support required to hold up the pelvic contents. The recto-vesical fascia consists of the two layers of the triangular ligament, the superficial fascia and the ischioperineal fascia. Of these, the last named is the most important in supporting the pelvic contents. A perineal tear that permits gaping always involves these sheets. When the ischio-rectal ligament is torn, the pelvic floor sags. But although it is possible that the part played by the levator muscle in supporting the pelvic contents may have heretofore been exaggerated, it is evident that, when it is torn, its restoration as nearly as possible *ad integrum* will always be of the highest importance to the patient, and the condition of this muscle should always be taken into consideration in the treatment of perineal laceration.

Character of the Injury. Injuries to the vaginal outlet occur generally during parturition. Consider for a moment what happens when a moderate-sized child comes into the world. Through an orifice which is normally from 2 to 3 cm., about an inch, in diameter passes a child's head which dilates the outlet until it forms a ring 33 cm., 13 inches, in circum-

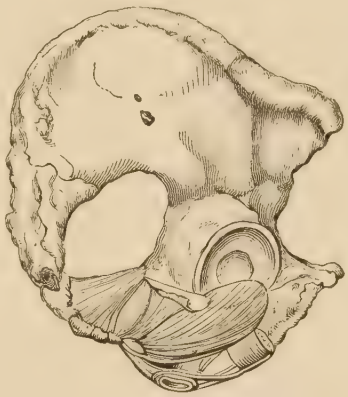
ference. It is true that this distention when brought about gradually and equably by repeated advance and recession of the fœtal head may be accomplished without injury, but it not infrequently happens that the delivery is somewhat precipitate, and, instead of gradual stretching, we have rupture of muscular fibres or fascial attachments.

The outlet, when compared with the capacious vaginal cavity within the pelvis, may be likened to the narrow vent of a funnel with a wide mouth. It would seem surprising that so comparatively small a passage is not more frequently injured during the birth of the head and shoulders of a child of ordinary size.

Injuries of the vaginal outlet due to parturition may be divided into three classes:

1. External or superficial tears.
2. Internal or combined external and internal incomplete tears.
3. Complete tears.

FIG. 407.



Levator ani and coccygeus, seen from without, after removal of part of hip bone and clearing out of ischiorectal fossa. (LUSCHKA.)

a Fibres of levator ani on vagina. *b.* Anus, with sphincter.

1. **The superficial external tear** begins at the introitus and extends backward, involving the superficial portion of the wedge of lax tissue behind it. The rupture may extend inward beyond the hymen to the side of the posterior vaginal column, which normally lies in close proximity to the vaginal outlet, but which during parturition, when the tissues are put upon the stretch, is found much further back.

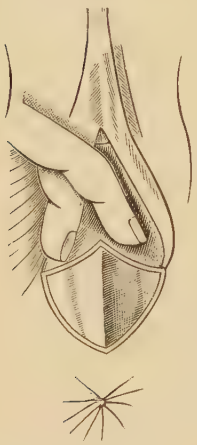
So long as a tear does not in any way affect the supporting structures the injury done to the outlet is relatively unimportant. A few superficial stitches are necessary in order that suppuration, granulation, and the formation of sensitive scar-tissue may be avoided. (Fig. 408.) Rupture of the fourchette is the rule, even in normal labors, and need not be repaired; but when the tear has a base of 2–3 cm., $\frac{3}{4}$–$1\frac{1}{2}$ inch, sutures are necessary. The patient should be placed with her body across the bed, the buttocks being made to overhang the side; the legs are flexed upon the thighs, and the thighs in turn upon the abdomen, the position being maintained by assistants or by means of a leg-holder. The labia having been drawn apart, the raw surfaces can be made out as two triangular areas separated at their apices, which are formed by the divided fourchette, and united at a common base.

The instruments required are (1) a needle-holder, (2) a small curved needle, (3) a few silk or catgut sutures 22 cm. (8 inches) in length.

The lips of the tear being held apart by the index and second fingers of the left hand, the needle is introduced near the upper angle of the tear about half a centimeter, $\frac{1}{5}$ inch, from the margin. After having been brought out in the bottom of the tear, it is re-entered near this point, and emerges on the skin surface on the opposite side at a point corresponding to that of its first entrance. The next suture having been

passed nearer the lower angle of the tear, both are tied, and the wound is almost completely closed. Two or three superficial sutures may be required to complete the approximation. During convalescence care should be taken not to make pressure upon the approximated surfaces with the finger or with the nozzle of the syringe, should a douche need to be given. The stitches may be removed about the eighth day. To do this the buttocks and labia are separated with the fingers and thumb, and the surface of the wound is cleansed by means of pledgets of cotton saturated with boric acid solution ; each suture, being caught in the dressing-forceps, is gently pulled forward until the loop is exposed, so that it can be cut close to the surface. The suture is withdrawn by making traction upon the end containing the knot, so that the smooth portion is drawn through the tissues.

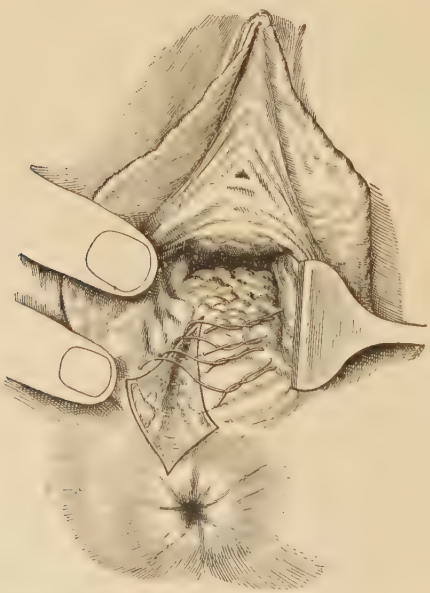
FIG. 408.



Superficial tear exposed by fingers parting labia minora.

2. **Combined Internal and External Tear.** In the second form of laceration the injury sustained during labor may appear as a gutter-shaped tear, which is generally in the median line on the skin surface, but within the vagina involves either one or both of the lateral sulci of the vagina. The laceration may vary in length from 2.5 to 5 cm., 1 to 2 inches, or may be even longer. It may be caused by pressure of the head or of the shoulder, the former

FIG. 409.

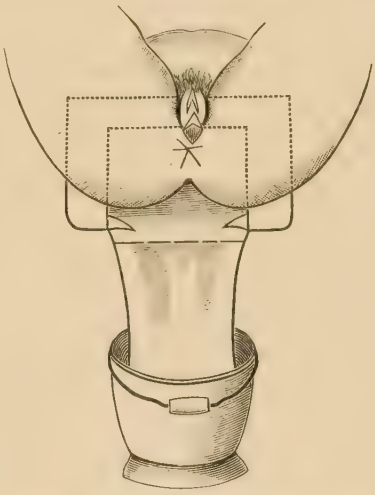


Superficial combined internal and external tear, showing portion of tear in vagina that may escape notice.

in its descent producing a tear inside the vagina which may be further

enlarged by the shoulder of the fœtus as it forces its way down between the levator fibres and their rectal attachments on one or both sides. In addition we generally have a superficial rupture of the fourchette. It not infrequently happens that this latter portion of the tear is the only one attended to, and that the most important part, being concealed within the vagina, escapes notice. (Fig. 409.) It is, however, the main injury to the supports of the vaginal outlet which should more especially be sought out and remedied. Immediate repair should be instituted. (Fig. 410.)

Fig. 410.



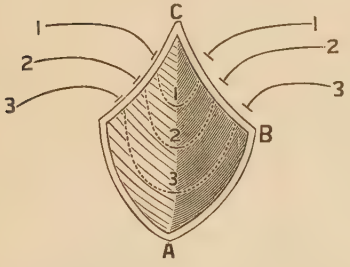
Patient in lithotomy position, on perineal pad, ready for the immediate operation.

Method of Operating. The method of operating for the closure of recent internal tears is somewhat as follows: The patient should be placed in the position just mentioned when describing the suturing of a superficial laceration; the perineal drainage cushion (Fig. 408.) should be placed under the buttocks, with the apron over the edge of the bed hanging into a bucket. In these cases it is generally better to give an anesthetic, unless the patient is confident that she can bear a moderate amount of pain.

The following instruments should be in readiness:

1. Needle-holder.
2. Small and medium-sized curved needles threaded with carriers.
3. Six strands of silkworm-gut.
4. One dozen medium-sized silk or catgut sutures.
5. Emmet's curved scissors, and the Sims' or Simon's speculum or a flat retractor. An Emmet's needle is by some operators preferred to the usual surgical needle. (Fig. 412.)

Fig. 411.



Same as Fig. 367, with internal sutures passed, ready to tie.

The anterior wall of the vagina being held back and the labia separated by the fingers of the left hand (Fig. 408). or by means of a speculum or retractor in the hands of an assistant, and the upper angles of the wound having been thus exposed, the first suture is passed just below the upper angle of the tear, and the next about a centimeter below this, and so on down to the other extremity. The needle should be introduced 5 mm. or more from the margin of the wound, since otherwise, if there is much contusion of the parts, the suture may cut through the weakened tissues. The direction in which the sutures are passed is a matter of some importance. The needle should be carried through the tissues in a direction toward the operator, and brought

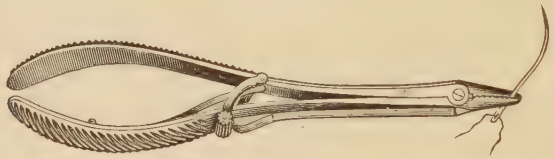
out at the centre of the tear; it is then re-entered and carried upward in a direction away from the operator to the point of exit, which should

FIG. 412.

Emmet's needle for suturing the pelvic floor.

correspond with that of entrance. In this way the approximation will be much better than if the sutures are passed in a plane at right angles

FIG. 413.



Needle holder.

to the surface. The part of the suture seen in the floor of the wound lies 1 or 2 cm. nearer the perineal angle of the wound than the lateral points of entrance and exit. (Figs. 411, 415, 416, 417.) Immediately

FIG. 414.

Needle armed with a carrier.

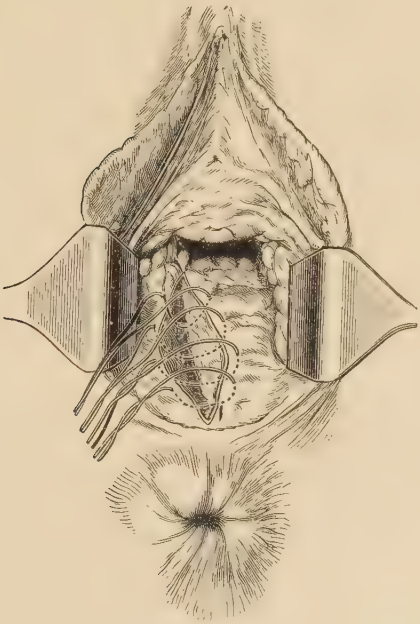
a suture has been introduced, it should be tied; or the ends may be clamped till all have been laid.

Near the vaginal outlet, the tissues being the least yielding just where the sutures enter the lateral wall, the part of the suture lying in the bottom of the wound is pulled upward. This is what we mean by a "lifting suture;" for it, silkworm-gut softened in sterilized water is the best material, being more elastic and smoother than either silk or silver wire, and less painful than the latter. On account of its elasticity it forms a symmetrical loop in the tissue, so that when the ends are brought together the constriction, which is often produced by the sharp angular loop made by silver wire, is avoided. Silkworm-gut, owing to its smoothness and non-absorbent quality, is not irritating, and sutures of this material may be left with safety in the vagina for several weeks.

To insure success in this operation we must bring about the approximation of the torn structures within the vagina, and not only those on

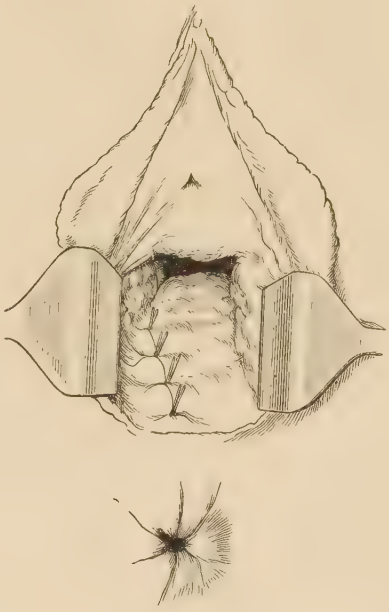
the skin surface. Two or three sutures introduced as described, with the belly of the sutures below the line of entrance and exit, will lift up a large tear, and approximate extensive raw surfaces and bring the torn edges of the fascia together in a most satisfactory manner. One or two superficial or half-deep sutures of fine silk on the skin surface will then complete the approximation. If, instead of adopting the method just outlined, all the sutures be passed from the skin surface in what

FIG. 415.



Internal stitches in position.

FIG. 416.



Internal stitches tied.

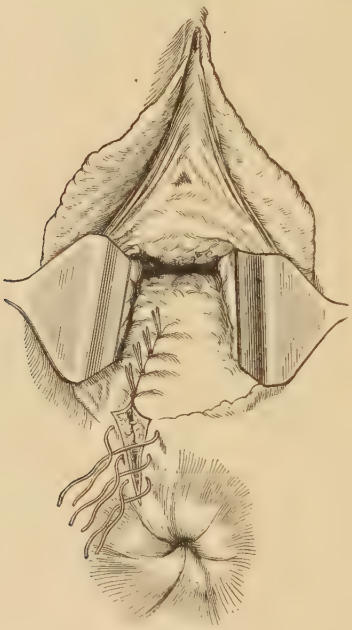
would at first sight appear to be the natural curve beneath the lacerated tissue, it is only too probable that the really important part of the tear —viz., that within the vagina—will be left ununited. In this way a pocket is formed in the vaginal wall, in which secretions may collect, so that any attempt at union will be frustrated, and a troublesome perineo-vaginal fistula may even occur. In any case, although there may be good external union and the skin perineum be perfect, a relaxed outlet will surely be left.

AFTER-TREATMENT. After the patient has been put to bed it will seldom be necessary to bind her legs together or make her keep strictly in the dorsal position. She may be allowed to turn slowly in bed, or even to elevate the knees, provided only that she keeps them together.

Catheterization may be necessary at intervals for the first day or two, on account of ischuria or retention, but the patient should always be encouraged to pass her urine voluntarily if possible. The bowels should be moved, after twenty-four hours, with citrate of magnesium or Rochelle salt given by the mouth. If there be straining at stool, the index finger

should be anointed and introduced into the rectum for the purpose of removing any scybalous masses that may be present. After the urine

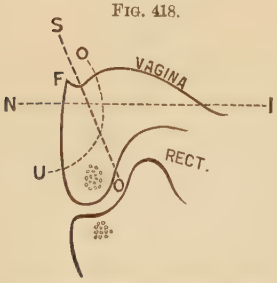
FIG. 417.



Internal stitches tied; external stitches in position.

has been passed the labia should be separated and 2 grams (ʒss) of iodoform and boric acid powder (1 : 7) may be dusted upon the wound. A pad of absorbent cotton is then applied, and held in place by a T-bandage. The sutures may be removed in from eight to ten days after the operation. The patient should be kept in bed from twelve to fourteen days, and should not be allowed to exert herself much for four or five weeks.

FIG. 418.



Sagittal section of posterior vaginal wall, perineum, and rectum.

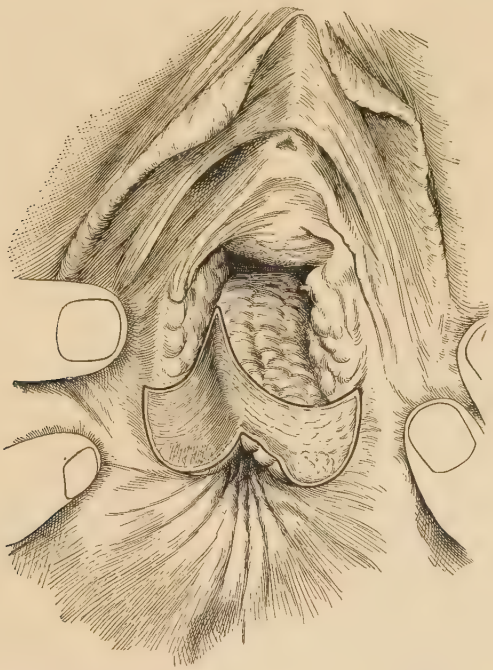
The area embraced by or represents an outside, more or less superficial tear. The area above IN represents a tear more on the inside of the vagina, and the area outside of so includes the whole skin perineum and sphincter ani.

3. **Complete Tear.** The third form of recent tear involving the rectum starts at the fourchette and extends back in the median line of the perineum through the sphincter ani, and to a variable extent involves the recto-vaginal septum. (Figs. 418, 419.) It must be remembered that the external tear occurs in the median line, while the internal rupture is always lateral, occurring on one or both sides. The function of the external sphincter muscle, when its fibres have been torn through, is lost, and as a result we may have incontinence of fæces and flatus. Yet such patients will often put off an operation for months

or years, until their condition is unbearable. An immediate operation is advisable in these cases, since, if it is successful, the patient will be spared much discomfort and misery. She saves time and the greater annoyance and suffering incident to a secondary operation. Again, immediately after labor there is less tension of the torn structures, owing to loss of muscle-tone.

Method of Operating. The woman should be placed in the lithotomy position, as described above. The complex tear is first reduced to a simple one, by closing the rent in the bowel, which is a very important part of the injury. (Fig. 420.) Beginning at the apex of the tear, a series of interrupted catgut or silk sutures is inserted. Buried catgut sutures may advantageously be employed for this purpose. The first

Fig. 419.

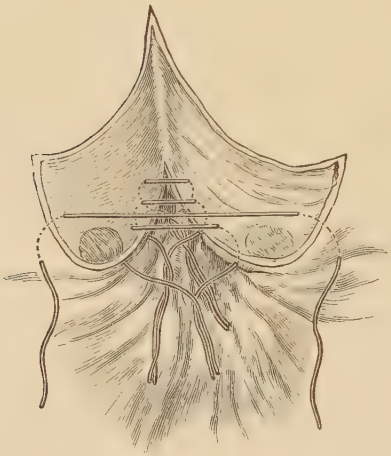


Complete tear, involving the recto-vaginal septum.

suture is introduced on the rectal side of the rupture, and it penetrates the tissues of the septum deeply enough (5 mm.) to ensure a firm hold. Two turns of the first knot and one of the second will make it hold securely. The remaining sutures are passed in a similar manner until the ruptured sphincter is reached. It is not unusual to find that on one or both sides the torn ends of the sphincter have retracted, leaving a pocket. It is of the utmost importance that this condition be rectified; the ends of the muscle must be sought out carefully and brought into accurate approximation. A tenaculum may be employed to draw out an end of the retracted muscle, which is then secured by means of one or two catgut sutures passed through it. The other end having been caught, the sutures are passed through it and pulled tight,

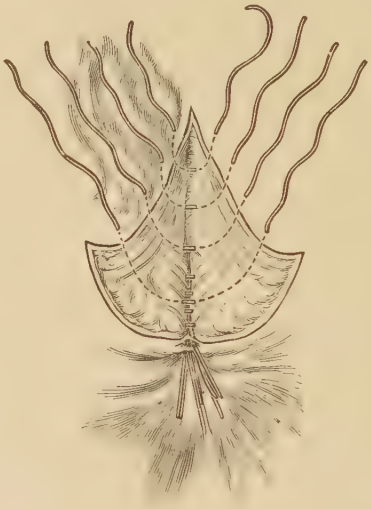
tied, and buried. To relieve undue tension upon these approximation sutures it is advisable to employ one or two silkworm-gut sutures, which

FIG. 420.



Complete tear; closing the rent in the bowel.

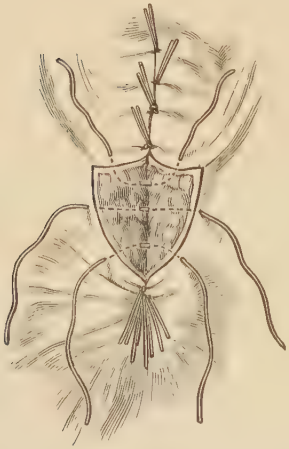
FIG. 421.



Deep interrupted lifting sutures in position.

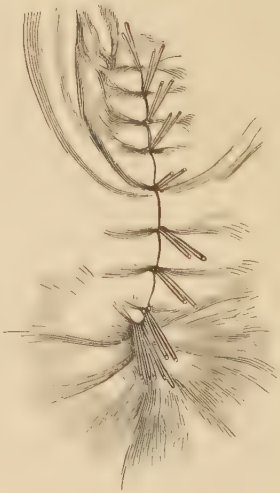
are made to enter and emerge in the muscle farther away from the torn ends and circle about $1\frac{1}{2}$ centimeters above the angle of the tear up to the recto-vaginal septum.

FIG. 422.



All sutures laid; vaginal sutures tied.

FIG. 423.



Internal and external sutures tied.

After eliminating the rectal complication, we have left a tear such as has been described, involving the fourchette and usually extending a

short distance upward in the median line, or into one or both sulci of the vagina. This part of the wound is closed by deep interrupted lifting sutures in the manner detailed when speaking of the second form of laceration. (Fig. 421.) After these sutures have been tied, it is advisable to employ a few superficial silk sutures to complete the approximation. (Figs. 422, 423.) To have union throughout, perfect approximation is necessary, and it is essential that the sutures be properly laid. In very deep lacerations it is sometimes advisable to use tiers of sutures, the first suture consisting of a running catgut suture laid in a plane near the bottom of the wound, and the next at a slightly higher level. The last tier may consist of interrupted silkworm-gut sutures, which are tied on the vaginal surface. An operation such as has been described will generally restore the relaxed outlet almost to its normal condition, if the parturient period has been properly conducted, so that puerperal sepsis is prevented. The repair may be postponed, and in some cases this has to be done, but only by an early operation can the parts be restored to their primitive integrity. All secondary operations are less efficacious.

AFTER-TREATMENT. The after-treatment is to be conducted in accordance with the general principles laid down elsewhere. The same rules as to the evacuation of the bladder and the bowels advised before and after other operations must be carefully carried out. Catheters can be sterilized by boiling for five minutes in a 1 per cent. soda solution. This procedure, however, is very deleterious to the ordinary rubber or gutta-percha catheter, and for this reason glass catheters are invaluable. Though they are sometimes broken in the boiling, this is of no great moment, as they are cheap, and by their use greater safety is insured.

In ordinary instances the nurse may be allowed to give the enema, but in cases of complete laceration the physician should take this duty upon himself. The index finger, smeared with vaseline, should be gently introduced into the rectum, in order to determine the exact direction of the canal; with this as a guide the syringe is carefully inserted and the injection is given slowly. This caution is not superfluous. More than once the point of the syringe has been thrust between the stitches passed through the perineum. One case is reported in which it was pushed through the coat of the bowel, and a laxative enema was forced into the pelvic cellular tissue. The patient died from the extensive sloughing which followed.

Straining during the act of defæcation must be avoided, and hard masses of fæces in the rectum must be removed by the finger of the physician. In doing this, pressure should be made toward the sacrum. As a rule, a vaginal douche is unnecessary. If the discharge is foul, but the patient has no fever, one consisting of a saturated solution of boric acid or of a 2 per cent. solution of carbolic acid may be employed, and if this procedure is followed by no improvement, the uterine cavity should be carefully explored and, if necessary, curetted.

A pad of absorbent cotton is applied loosely over the vulva; it is at first changed every two or three hours, and later three times daily.

All perineal cases must be kept in bed for two weeks; on the eighth day the external sutures are removed. The silkworm-gut sutures should

be pulled out so that the wound surfaces are drawn together, rather than apart. The internal sutures can be removed at the end of two or three weeks.

IMMEDIATE REPAIR OF THE LACERATED CERVIX.

The primary operation for this condition is only rarely indicated. It is impossible for labor to take place without more or less extensive rupture of the cervical tissues, but even in cases of severe laceration, it has generally been thought better, as a rule, to remedy any defect later, rather than add to the severe trials of the woman at the time of labor by immediate operation. In instances of persistent hemorrhage from the circular artery, however, it may be necessary for the safety of the patient to repair the lacerated structures at once in order to stop the bleeding, and not a few cases are quoted in which life has apparently been saved by resort to this procedure. The most recent literature upon the subject shows an increasing tendency to undertake the immediate operation in less severe cases also, and when we consider the later dangers of a lacerated cervix to the patient and the natural repugnance that exists in many cases to the secondary operation, together with the serious consequences resulting from the neglected cervical injuries, the question arises whether it is not better to unite at once the raw surfaces and thus effect two purposes at once: (1) the closing of avenues by which infective material may enter, and (2) the avoidance of injurious results which may follow from the neglect to rectify the condition later. It is true that the tumefaction of the tissues may make it difficult to secure proper coaptation, but with a little care any objection to the procedure on this score may be overcome. Some obstetricians prefer to wait for a week or ten days before operating, and then, after scraping the surfaces of the torn tissues with a knife blade, approximate them with sutures. To prevent pain, cocaine (in from 1 to 5 per cent. solutions) is employed locally or hypodermically.

Method of Operating. The operation itself is comparatively simple. With the patient in the lithotomy position, the cervix is drawn down and held in position by means of a tenaculum or a volsella, and stitches are about one inch apart from above downward. As careful approximation as possible should be obtained, a result which may be promoted, if necessary, by a few superficial stitches. A teaspoonful of iodoform and boric acid powder (1 : 7) may be dusted over the wound. The stitches may be removed about the twenty-first day.

CHAPTER XXX.

THE INDUCTION OF ABORTION AND OF PREMATURE LABOR.

Definition. Before dealing with the various means at our disposal for the artificial emptying of the uterus before term, it is necessary to discuss briefly the significance of some of the numerous terms which have been applied to the interruption of pregnancy. Zweifel distinguishes two main classes of cases: (1) those in which the ovum is usually discharged *in toto*, and (2) those in which the fetus is extruded after rupture of the membranes. Thus, he would apply the term *abortion* to expulsion of the ovum before the end of the sixteenth week, and that of *premature labor* to its expulsion between the beginning of the seventeenth week and full term. Although much can be said from an anatomical standpoint in favor of this classification, the fact remains that when operative interference is indicated the question whether we are dealing with a viable or a non-viable child is often of predominating importance as regards the selection of the method to be employed. For our present purpose, therefore, it will be more convenient to adopt a different division, and to consider *abortion* as a delivery of the fetus before it is viable—*i. e.*, before the end of the twenty-eighth week; while the discharge of the uterine contents between this time and full term will be spoken of as *premature labor*. Some authors would distinguish between these terms as follows: *Abortion*, interruption of pregnancy during the first three months; *miscarriage*, interruption at some time between the fourth and the seventh or eighth month; whereas *premature delivery* would apply to delivery between the twenty-eighth and the thirty-eighth week.

Mention has already been made in another chapter of cases in which the exciting cause of abortion or of premature labor has been beyond our reach; but a very important class still remains, namely, those instances in which the physician himself, for good cause, finds it necessary to bring about the premature discharge of the contents of the pregnant uterus.

The induction of abortion or of premature labor in non-pathological conditions is rightly regarded in civilized communities as a moral and civil crime, and one to be punished with severe legal penalties. Although, therefore, it is generally agreed that medical science may on rare occasions be above the law, it is evident that it must always be the first duty of the physician to place both his patient and himself beyond the imputation of any intention to commit a serious crime. There should be no false modesty or concealment about the operation. Intentional secrecy may, unjustly, be looked upon as *primâ facie* evidence of criminality. When, however, the mother is in such physical condition that further continuance of gestation would be perilous to her life, it is generally conceded that interference with pregnancy is not

only justifiable, but a solemn duty. But so serious a course should never be decided upon by one physician alone. To demonstrate absolutely the absence of criminal intent should be his first thought. This end may be best accomplished by calling in consultation a colleague, and not proceeding to operation until the necessity for it has been carefully demonstrated, a full explanation of the circumstances of the case has been made to the members of the family more directly concerned, and the course to be pursued has met with their full approval.

The first point to be considered in deciding whether an interference with gestation is necessary is the physical and mental condition of the mother. Should it seem to the physician, after careful thought and consideration of the particular case, that the woman's life will be seriously threatened by allowing the pregnancy to continue to term, the next question to be decided is, whether it may not be possible to wait until there will exist some chance for saving the life of the infant as well; in other words, whether we ought to bring about an abortion or a premature labor.

Indications. Among the conditions in which interference with gestation may be justifiable are the following:

1. Death of the fœtus in utero.

2. Grave pathological conditions of the viscera, such as advanced cardiac disease, phthisis which is clearly making rapid progress on account of the pregnant condition, kidney lesions threatening eclampsia, and persistent and advancing jaundice. An acute nephritis is especially dangerous when it occurs during pregnancy, and experience has shown that the emptying of the uterus has often cut short the process.

3. In the vomiting of pregnancy which has resisted all other measures, and where the patient's strength is rapidly failing, the induction of abortion may be necessary as a last resort. Still, it is only right to wait as long as we dare, and sometimes to give the stomach long intervals of entire rest, the strength of the patient being partially supported meanwhile by nutrient enemata. The various surgical procedures which have been tried are very rarely of any use in these cases. Occasionally applications to the cervix have appeared to be beneficial, and Martin states that dilation in his hands has been successful; yet Runge holds that this method is absolutely unreliable.

4. Certain diseases of the blood and of the nervous system—*e. g.*, pernicious anæmia, leucocythæmia, acute melancholia, acute mania, and inflammatory affections of the brain—apparently depending upon the pregnancy or increased by it. In pernicious anæmia Bischoff prefers the induction of premature labor, and denies that abortion is necessary; he argues that anæmia becomes dangerous only during the latter half of pregnancy.

5. Where the mechanical conditions are such that the birth of a viable child becomes an impossibility; for example, in cases of retroflexion of the gravid uterus with incarceration below the superior strait, or an abnormally small calibre of the vagina such as would prevent the passage of the child. Again, the presence of benign or malignant tumors which would effectually preclude delivery of a child at term through the natural passages, and hernia of the uterus resisting all other treatment bring up the question of the advisability of putting an end to the pregnancy.

When the uterus is retroflexed and incarcerated, and when all attempts, even under narcosis, to raise it above the superior strait have proved ineffectual, the indication for abortion is absolute. Except in these cases, however, it is always the duty of the attending physician to weigh carefully the question how long it may be safe to delay emptying the uterus; and if it be possible, without grave risk to the mother, to wait until there is a chance of securing a living child, interference in the later stages of pregnancy should be preferred. Under some circumstances in cases of narrowing of the vagina, where the smallness of the calibre is due to cicatrices, lateral incisions or other operations may be indicated. In cases of obstruction, from whatever cause they may arise, the question of Cæsarean section with its various modifications should always be taken into consideration.

Methods of Inducing Abortion.

The mechanism of the premature discharge of the contents of the pregnant uterus resembles in the main that of normal labor. In bringing about the expulsion by artificial methods we should, as far as possible, imitate nature, the essential element in the operation being to secure contractions of the uterus and the consequent evacuation of the organ. The process is really a reflex act, implying the application of a stimulus and a conveyance of it to nerve-centers, from which an impulse is sent down to the peripheral nerves which causes the uterus to contract.

Such a reflex act may be brought about in various ways, and the seat of the original stimulus need not of necessity be the uterus itself. It has long been known that irritation applied to the breasts, and more especially to the nipples, is often followed by uterine contractions of greater or less intensity. This fact has been taken advantage of by Scanzoni, who has formulated a method of inducing abortion by irritation of the nipples. But, as might be expected, the strongest and most effectual contractions can be brought about by the application of the stimulus directly to the interior of the uterus.

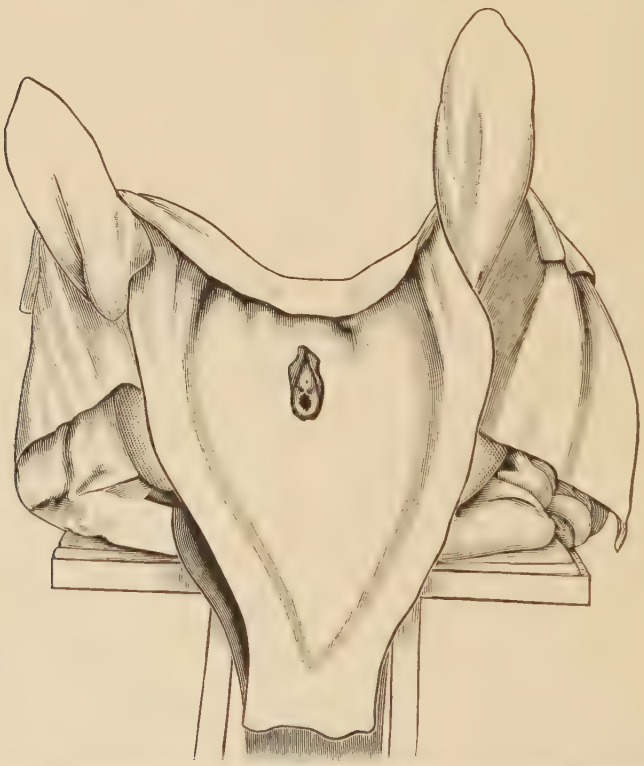
Stimuli may be distinguished as (1) chemical, (2) mechanical, (3) thermic, (4) electrical. An accurate classification along these lines, however, presents great difficulties, since some stimuli may act in more than one way. For instance, drugs may have a chemical and a mechanical effect and hot water injections may act as a mechanical as well as a thermic stimulus. For practical purposes stimuli may be conveniently discussed in three main classes: (1) Drug stimuli. (2) Stimuli applied to some region other than the interior of the cervical canal or the uterine cavity. (3) Stimuli applied directly to the interior (*a*) of the uterine cavity or (*b*) of the cervical canal.

1. *Drugs.* Many drugs have been employed for the purpose. Among the chief of these so-called ecbolics are ergot, cotton-root-bark, quinine, pilocarpine, the smut of Indian corn (ustilago maidis), and various essential oils, especially those of savine, rue, parsley, tansy, and pennyroyal. Of all these the most effective is undoubtedly ergot, which is capable of bringing on, as well as of strengthening, uterine contractions. But the contractions excited by ergot have a tonic character in contradistinction to the normal clonic or recurrent contractions which it should be our aim to secure. Thus, even when given in quite

large doses, it often fails to accomplish fully the object in view, and operative interference may become necessary to complete the evacuation of the uterus. Of the other drugs of this class, it may be said that their action is even more uncertain than that of ergot, and the exhibition of them in doses sufficient to cause abortion is always accompanied by considerable risk and even danger to the life of the patient. Oil of tansy and oil of rue are much relied on by the laity for the production of abortion, and almost every day one may read of fatal results attending their use. Oil of tansy in large doses is said to excite epileptiform convulsions; quite recently one of my colleagues met such a case in his practice.

Abortion has been brought about by reflex stimulation of the uterus through free purgation. Magnesium sulphate in heroic doses has not infrequently been used for this purpose. Its action, however, is quite uncertain, and nothing can be said in favor of this method. It

FIG. 424.



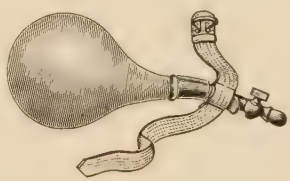
Field of operation and the neighboring parts protected by gauze diaphragm, towel and stockings.

is probable that the irritant purgatives have much more effect, but their use in sufficient doses is highly dangerous. It is more than possible that oil of tansy and oil of rue act in this way. In brief, it may be said that the employment of drugs for bringing about the evacuation of the uterus should be entirely discarded. Their action is uncertain and slow, and in effective doses their use is always accompanied with danger.

2. *Scanzoni's method*, which consists in massage or rubbing of the nipples, is uncertain in its action and sometimes exceedingly painful to the patient. It is not to be recommended.

Tamponade of the vagina is very effective in some cases, and, as has been said, is often employed in cases of inevitable abortion to stop the hemorrhage and to bring about dilation of the cervix and contractions of the uterus. The tampons may be made of gauze or cotton, or the colpeurynter more especially recommended by C. Braun may be employed. The external parts having been carefully disinfected, the vagina is first rendered as aseptic as possible by flushing with several douches; it is then washed with soap and water, a cotton sponge being used, and afterward with a 2 per cent. solution of creolin, followed by a 1 : 1000 solution of mercuric chloride. After having been finally irrigated with an abundance of normal salt solution, it is dried with small pledgets of aseptic absorbent cotton. In the further steps of the procedure it is advisable to employ a sterilized gauze perineal apron, the operator working through a slit in it which corresponds to the vulvar opening. Two or three tampons of sterile absorbent cotton, or of 10 per cent. iodoformized or plain sterile gauze, are then introduced on either side of the cervix, and are held in position for several minutes, moderate pressure being employed. After this a fresh tampon is introduced, which is followed by others until the vagina is completely filled. (Fig. 424.) Dry tampons stay in place much better than those which have been soaked in disinfectant solutions, and are quite as efficient. In the place of these tampons the colpeurynter may be employed. (Fig. 425.) The tampons or colpeurynter should not be allowed to remain in position more than twenty-four hours. After their removal a 2 per cent. solution of carbolic acid may be employed as a douche. In view of the fact that in susceptible patients poisoning has been sometimes produced by carbolic acid, many authorities prefer to use sterile normal salt solution. If the first tamponade does not produce the desired effect, a second or even a third may be employed. The method is usually effective, but it has the disadvantage that it is almost always slow and not infrequently painful.

FIG. 425.



Colpeurynter.

Kiwisch's method consists in the injection of warm water against the cervix. He recommends the use of a fountain syringe and water at a temperature of about 42.5° C. (106° F.). The douche is given two or three times daily for fifteen minutes at a time, the stream being directed against the cervix. Care must be taken not to inject air into the cervical canal. The heat of the water and the force of the stream are important factors in this method, which, although slow, is often effective.

Electricity. The use of the galvanic current has been strongly recommended by some authors. The positive pole is applied over the sacral region or over the lumbar vertebræ, and the negative pole is applied to the exterior of the cervix in the posterior cul-de-sac. The method has not, as yet, been much employed.

3. (*a*) *Krause's method* consists in introducing a flexible elastic bougie between the wall of the uterus and the membranes. The procedure has been modified in various ways. Some authorities allow the instrument to remain in place from twelve to twenty-four hours, while others hold that it should be introduced and then immediately withdrawn. Bougies are preferable to catheters, since in the employment of the latter there is danger of introducing air into the uterine sinuses. The instrument must be soft and flexible, otherwise there is great risk of perforating the amniotic sac, or even the uterine wall itself. Steel sounds should not be employed. Strict asepsis of the external genitals and vagina and of the hands of the operator and his assistants is to be observed.

The procedure may be carried out as follows: The cervix being thoroughly exposed, the bougie is pushed gently in until the tip lies near the fundus. After being allowed to remain for several minutes it is withdrawn, and the vaginal canal is packed with tampons; or the bougie may be left *in situ* and the tamponade of gauze be made around it. Should there be much hemorrhage, evidenced by blood flowing down along the bougie, so that we have reason to suspect that the placental site has been invaded, the bougie should be withdrawn and reinserted in another direction. The hemorrhage will then probably cease spontaneously. If, however, it becomes alarming, a firm vaginal tamponade may be made, or preferably a colpeurynter may be inserted into the vagina close up to the cervix and allowed to remain for some hours, unless indications for its removal should appear. This method is not to be recommended during the first two or three months, but in the later stages of pregnancy it is one of the most satisfactory which we possess. It usually acts promptly and effectively. The operation in a crude form is often resorted to by women in order to free themselves from the consequences of pregnancy, frequently with disastrous results, which are due almost always to infection following a total lack of asepsis. It is also in vogue among the unsavory class of men and women known in communities as "abortionists."

Hamilton's method consists in the circular detachment by means of the finger of the fœtal membranes for a short distance above the internal os. The employment of this method presupposes a dilatation of the cervical canal so that it is capable of admitting a finger. Its action is similar to that of Tarnier's method, but is not so certain.

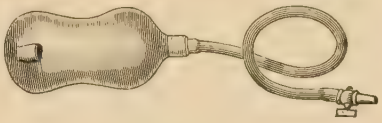
Tarnier's method consists in the insertion of a dilatable rubber bag into the cervical canal and extending slightly above the internal os. The distention of this bag with water, and the subsequent separation of the membranes from the decidua for a certain distance above the internal os, excite uterine contractions, with a coincident dilation of the cervix. Except that in Tarnier's method the bag is inserted somewhat higher up, the procedure differs in no essential respect from that of Barnes.

The advantages of this method consist in the preservation of the bag of waters, and in the simultaneous induction of uterine contractions and of dilatation of the cervix.

In using any of these rubber bags it is necessary that the material be new and be well preserved, otherwise they will be very apt to rupture when distended and thus allow a quantity of water to get into the

uterus. They should be rendered thoroughly aseptic, both inside and outside, before being employed, and the water used for filling them

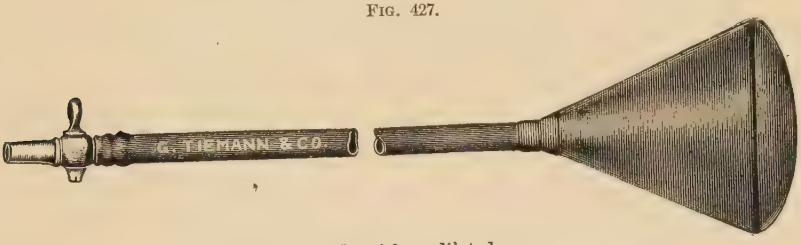
FIG. 426.



Barnes' bag.

should previously have been boiled, so that if rupture takes place no great harm may be done. This method usually acts quickly and

FIG. 427.



Voorhees' bag, dilated.

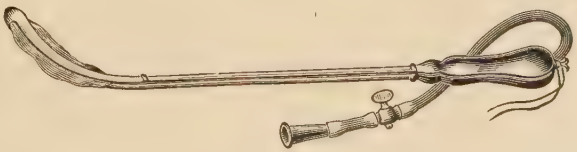
thoroughly, and is especially to be recommended in pregnancies be-

FIG. 428.

Voorhees' bag, collapsed.

tween the third and the end of the sixth month. (Figs. 426, 427, 428, 429, and 430.)

FIG. 429.



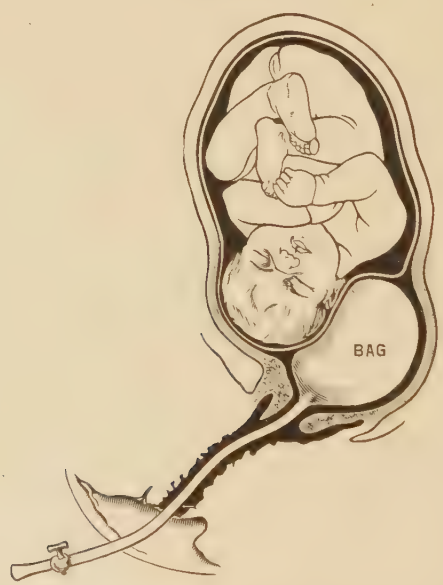
Tarnier's uterine dilator.

The Bossi Dilator. This instrument is used in certain obstetrical cases in which a rapid dilation and immediate delivery are called for. Among the many objections to its use for this purpose may be mentioned: The extensive laceration of the cervical tissues; the complicated mechanism

of the instrument, which renders very difficult the thorough sterilization of all its parts. The consensus of opinion, on the whole, is that it is not a safe instrument to use for carrying out a forcible dilation of the cervix.

Cohen's method consists in the injection of fluids between the membranes and the uterine wall. No special apparatus is necessary, since one which will serve all purposes can readily be improvised. The nozzle of the syringe or douche bag should be from $\frac{1}{8}$ to $\frac{1}{4}$ inch, 0.31–0.62 cm., in diameter, and from 6 to 8 inches, 15–20 cm., in length. It is better to employ a sterilized piston-syringe, which will admit of the injection being made more gradually. The nozzle should be introduced carefully and the fluid injected slowly, so that rupture of the membrane may be avoided. From 1 to 3 ounces, 30–90 cc., of the sterile solution will probably be sufficient. The apex of the nozzle should be passed about two inches, 5 cm., up the cervix beyond the external os. The distance will, of course, vary according to the duration of pregnancy and consequent size of the uterus. All air must be expelled from the apparatus before the insertion of the nozzle. Should the desired effect not follow in the course of six hours, the injection may

FIG. 430.



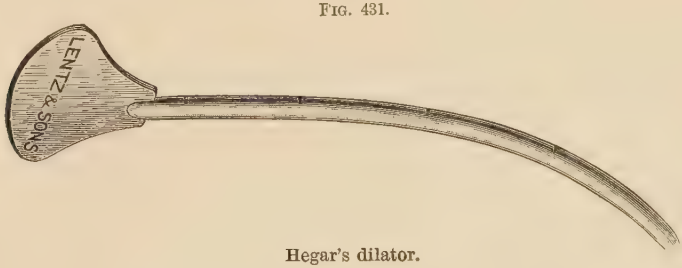
Tarnier's uterine dilator *in situ*: the bag is round in shape, but is compressed by the intra-uterine tension.

be repeated. The method is not to be recommended. Septic infection has often been observed, much more frequently than after employment of the majority of the other methods. Cases of thrombosis and embolism have also been reported, possibly due to the injection of air into the uterine sinuses. The advantages offered by it are that it is not only prompt in its action, but also very certain.

Scheel's method, with its modifications, depends upon the drawing off of the amniotic fluid, thus causing a more or less extensive separation

of the membranes from the decidua and rendering the ovum a foreign body, which must naturally excite uterine contractions. The point selected for penetration or rupture of the membranes may be at the internal os, or higher up, so that a valvular opening is obtained. It is advisable to prevent, as far as possible, the entrance of air into the cavity of the amnion, since it is impossible to say how long it may take before the pains set in and the process terminates. Sometimes labor-pains come on in two or three hours, but at other times their appaarance may be delayed for as many days. In the latter case there is danger that septic infection may follow the admission of air. Scheel's is probably the most certain of the methods employed for the induction of labor, but it possesses several disadvantages, not the least of which is that in almost every case its employment is followed by a dry labor, if the membranes are punctured at the internal os. The fact that the amniotic fluid has escaped, and thus left a solid mass, the fœtal body and membranes, to be expelled by the uterus, renders the dilation of the cervix a slower and more painful process. The contractions of the uterus are to a great extent ineffective, the laws of hydrostatics no longer applying, since the uterus now contains solid and not fluid contents. Again, it has been found that not infrequently portions of the membranes are left in the uterus. The former of these objections can be overcome by adopting the modifications suggested and carried out by Hopkins and Meissner. They make the puncture some distance above the internal os, so that enough of the amniotic fluid drains away to bring on uterine contractions, while sufficient still remains behind to be of value in dilating the cervical canal for the after-coming parts of the ovum. In advanced pregnancy it is best to allow the water to drain off slowly. Various kinds of instruments, from a simple pin or finger-nail to a complicated aspirating-needle, may be made use of.

FIG. 431.



Hegar's dilator.

(*b*) *Dilation of the Cervical Canal.* This may be accomplished in many ways. It may be called for as the introductory step in carrying out other methods—*e. g.*, Hamilton's—where it is necessary to gain entrance for the finger to the uterine cavity. The cervix may be dilated, if it is soft enough, by means of the finger, by Barnes' bag, or by metal or hard-rubber dilators. Dilation by means of the Barnes bag is effective and comparatively safe and speedy. It is more applicable to the induction of premature labor than of abortion. Digital dilation is in early cases a difficult procedure. Moderate dilation with easily sterilized metal or hard-rubber dilators is generally to be preferred. (Fig. 431.) Though not always effective, it succeeds in the majority of cases, and has the advantage of being one of the safest methods known.

When the patient presents herself in the first two or three months, and the necessity for putting a stop to the pregnancy is absolute, the swiftest and surest method in the hands of a skilled operator is by means of dilating and curetting. The procedure resembles somewhat that pursued in gynecological cases. The cervix is dilated with a steel branched dilator to a half or a full inch. The ovum is then separated, if possible, with a dull curette, and the whole is withdrawn with uterine dressing-forceps. The cavity is then gone over carefully with a sharp curette. Frequently the ovum has to be brought away piecemeal. The whole operation can be done in from ten to twenty minutes. It is absolutely sure, and with proper precautions should never be dangerous.

Whenever possible after artificial dilation of the cervix and rupture of the fœtal sac, the ovum and its membranes should be removed with the finger protected by rubber gloves. In many instances this is a safer and more satisfactory procedure than the use of the curette.

Methods of Inducing Premature Labor.

For this purpose it is possible to use any of the methods which have been spoken of in dealing with the induction of abortion. But, as has already been said, in this connection, a new factor is encountered, namely, the possibility of obtaining a viable child, while at the same time the mother is relieved of a dangerous encumbrance. Whereas in the former case the fœtus may be regarded as a foreign body, to be gotten rid of by the means most conducive to the welfare of the mother, it now presents itself as a living being, whose life may be put nearly on a par with her own. In choosing methods, then, we are restricted to those which will give the infant the best chance of life consistent with the safety of the mother. For this reason methods such as that of Scheel, which depend upon the withdrawal of the liquor amnii, are not advisable. Since their use entails a "dry labor," they increase to some extent the risks to the child. It will perhaps be more convenient to state, first, the procedure at present adopted by most of the prominent obstetricians in this country, and then to speak briefly of the advantages and disadvantages of the other methods.

Operation. The cervix is dilated gradually to one inch with a steel branched dilator. The membranes are then peeled up from the lower uterine segment with a uterine sound or with the finger. This step has been recommended by Jewett, and in the hands of a skilful operator it would seem to facilitate matters a good deal. One or two elastic bougies (English No. 10 or 12) are then passed between the uterus and the membranes. If a catheter is employed instead of bougies, the proximal end having been cut off and a stylet introduced, the catheter is passed up as far as it will go, the lower end, if any remains outside, being seized with a Keith's forceps and carried into the uterus bit by bit. The cervix is then packed with gauze. Instead of the above method, one of the bags recommended respectively by Champetier de Ribes, Voorhees, and Barnes may be used. Labor is usually completed in from twenty-four to thirty-six hours. In urgent cases the dilation may be completed with the hands, or the Bossi dilator, or, after the os internum is obliterated, by means of water-bags. In extreme emergencies Dührssen's incisions may be employed after the os internum is effaced. But, con-

trary to the practice of this author, the incisions should be sutured immediately after labor.

With respect to other methods, it may be said that the use of drugs is most emphatically to be condemned. Scanzoni's method is uncertain and painful and possesses only historical interest. Tamponade of the vagina is a fairly reliable and a safe method. In placenta prævia the colpeurynter is to be preferred. If the bags are not at hand, the cervix must be dilated rapidly and a podalic version performed, so that a bag may be brought down to act as a tampon and thus prevent a serious hemorrhage. Both these and Kiwisch's method are slow in their action, but they offer the advantage of preserving the membranes unruptured. Krause's method is one of the best which we possess, more especially if care be taken not to puncture the membranes. Hamilton's method and Tarnier's method are reliable and are comparatively easy to carry out. Cohen's method is equally certain, but it is not so simple a procedure, and is objectionable on account of the danger of the injection of air into the uterine sinuses. Scheel's method and its modifications have the disadvantages attaching to a dry labor, but when the fœtus is dead and the case is not urgent, it is one of the best at our disposal. It is often slow in its provocation of uterine contractions, but when these have been once established delivery as a rule is speedy. Although many living and viable children have been born in cases in which it has been employed, when the chances for the child's life are weighed the method must be considered inferior to those in which the amniotic membranes are left intact. The employment of tents, apparently even under the most aseptic precautions, for dilation of the cervical canal has often been followed by infection. Tarnier's procedure is better and is not difficult to carry out. Digital dilation is comparatively simple and, although sometimes slow, has been effected in an hour or two by many operators. In general, therefore, it may be said that in urgent cases—*e. g.*, in eclampsia—where it is necessary to empty the uterus as quickly as possible, the method first described or some modification of Tarnier's procedure is to be preferred. In cases of placenta prævia with severe hemorrhage the colpeurynter is highly efficacious. When the case is less pressing it is always advisable to be content with gradual dilation, and to leave the bag of waters unruptured till later. All other things being equal, the method should be chosen in which the individual operator has the most experience. The procedure of Krause and Tarnier and the employment of the colpeurynter are all applicable.

After the expulsion of the ovum in abortion or premature labor the membranes and placenta should be minutely examined, and we should make sure that the uterus has been completely emptied. If this has been done, and if all the necessary manipulations have been carried out with strict aseptic precautions, a normal puerperium may be expected. The management of such cases is similar to that after spontaneous labor.

Retained and Adherent Placenta.

It occasionally happens that the birth of the fœtus is followed almost immediately by the delivery of the placenta. But, as a rule, from ten to thirty minutes may be devoted to the necessary care of the mother

and child, while the expulsion of the placenta is awaited. During this time the uterus should carefully be watched, the hand of the nurse or doctor being kept on the abdomen to control the fundus.

Retained Placenta. Not infrequently the uterine contractions, together with the pressure exerted by the abdominal muscles, fail to cause the delivery of the placenta, which in such cases is usually found resting in the uterus. To such a condition the term *retained placenta* is applied.

Adherent Placenta. More rarely the placenta is not only retained *in utero*, but it remains fastened to the uterine wall. To this condition the term *adherent placenta* is applied. Of necessity, an adherent placenta must also be a retained placenta, but since the converse is by no means true, for the sake of simplicity, in describing the methods of dealing with such cases, it is more convenient to keep the two conditions distinct.

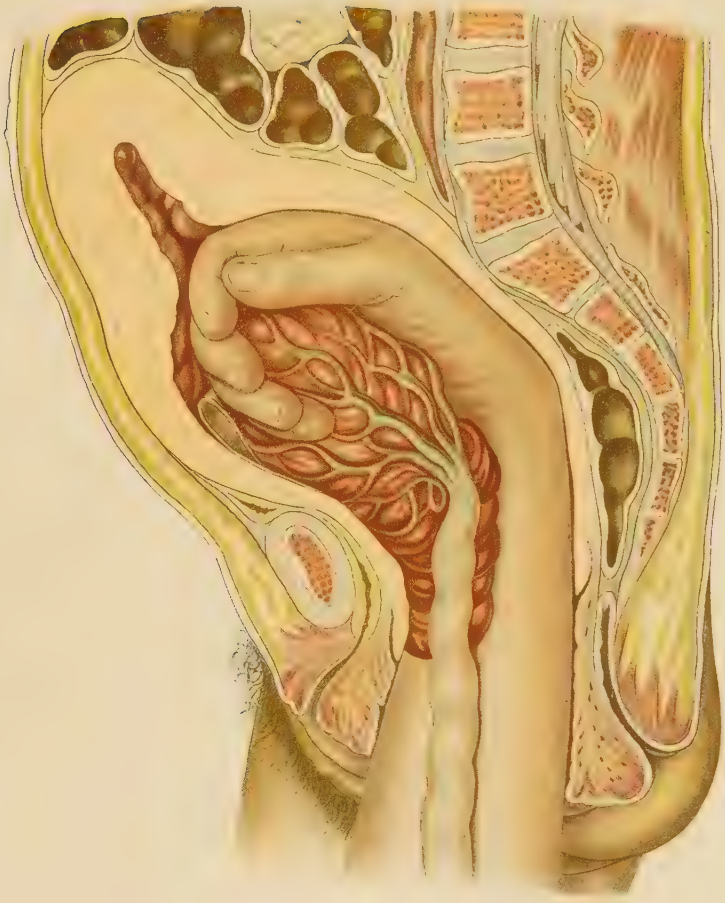
Mechanism of Placental Separation. To obtain a clear idea of the subject it is necessary to understand the mechanism which brings about the natural detachment of the placenta from the uterine walls. The chief factor is the expulsive force of the uterine contractions. As the uterus becomes smaller the area of the placental site is lessening, tending to separate the placenta from its attachment. The expulsion of the placenta may take place in either of two ways. The first few contractions of the uterus after the completion of the second stage may be sufficient to loosen the placenta entirely, and to expel it folded lengthwise of the uterus in a more or less fusiform shape. They may not, however, detach the whole placenta, but only its central portion. The marginal attachment may still remain, blood collecting in the cavity formed between the central portion of the placenta and the uterine wall. The blood-accumulation, together with further contractions of the uterus, then forces the placenta down through the opening in the membranes, so that it emerges by its amniotic surface from the outlet, dragging the membranes after it. In either case, normally all the placenta, together with the membranes and the superficial layer of the decidua, should be expelled.

Causes of Retention of the Placenta. The placenta may be retained in the uterus by reason of feeble contractions, or, in other words, from inertia uteri. A full bladder, a rectum packed with fæces, or a pelvic tumor may act reflexly to prevent the efficient action of the expulsive forces. Sometimes, though wholly expelled from the uterine cavity, it may still be retained in the roomy vaginal vault.

Causes of Adherent Placenta. One of the most frequent factors leading to adhesion of the placenta to the uterine wall is syphilis. A non-specific placentitis is a very rare condition, and when present it may lead to adherent placenta. A chronic endometritis is sometimes responsible for this complication.

Treatment of the Retained Placenta. It is a cardinal rule, as a precaution against infection, to allow nothing, whether finger or instrument, to enter the uterus or vagina after labor, if possible to avoid it. The risk to the patient, even in these days of asepsis, is greatly increased by manipulations within the passages at this period. Should the expulsion of the placenta be delayed beyond half an hour, it is well to try, first, the effect of emptying the bladder. It not infrequently happens that, although it may have been carefully emptied before, the bladder becomes

PLATE XXXVI.



Manual Extraction of Placenta.

distended during the progress of the second stage of labor, and its evacuation may succeed in evoking vigorous uterine contractions and the prompt expulsion of the placenta.

If it be quite certain that the bladder and rectum are empty, Credé's method of expulsion should be tried. Traction upon the cord is not permissible. When the placenta is not yet detached from the uterus, pulling upon the cord may cause a partial separation, with alarming hemorrhage. Rough traction may even result in complete inversion of the uterus. If the use of Credé's method does not prove successful

FIG. 432.

Manual extraction of placenta from lower uterine segment. (After RIBEMENT DESSAIGNES and LEPAGE.)

at the first attempt, it may be employed repeatedly and patiently at intervals, but no violence should be used. Well-directed manipulation according to Credé's method rarely fails if the fundus is carried well backward to bring the uterus nearly in line with the vaginal axis, and the woman is requested to "bear down" forcibly during the manipulation. As the placenta is being delivered, the membranes should be twisted gently into a cord and the whole slowly withdrawn. This procedure facilitates their removal and tends to prevent leaving behind fragments that may favor hemorrhage or infection. If expulsion be not

effected by expression after a thorough trial, it will be necessary to institute a careful examination, in order that the cause of the retention may be determined. Should the placenta be found lying in the upper part of the vagina, it can be withdrawn gently by means of one or two fingers pushed up past it and then hooked over its upper margin. The extraction may be assisted by pressure from above through the abdominal wall.

Treatment of Adherent Placenta. When an examination shows that the placenta still remains in the uterine cavity notwithstanding the manipulations that have been described, we may reasonably suspect adherent placenta, and should take steps at once for bringing it away. In pre-antiseptic days the expectant treatment may have been allowable in view of the fact that the removal of the adherent placenta was considered, and justly so, a dangerous operation, the mortality being from 7 to 9 per cent. of cases so treated. The patient and persistent use of Credé's method may bring about the separation and expulsion of a moderately adherent placenta. Where this has not succeeded after one or two hours, or earlier if hemorrhage is occurring, we must proceed to extraction. Chloroform or ether should be administered to light secondary anæsthesia, and the outer genitals of the woman and the hands and arms of the surgeon should be rendered as nearly as possible sterile. The cord is taken in the left hand and gentle traction is made till the slack is taken in; the right hand and forearm are inserted into the vagina, the fingers following up the umbilical cord as a guide to its insertion. The so-called hourglass contraction, formerly so much spoken of as interfering with the manual extraction of the placenta, is caused by the meeting of the dilated or easily dilatable lower uterine segment with the more firmly contracted and less dilatable upper segment at the retraction-ring. Should there be trouble at first in entering the uterus, either at the cervix or at the site of the retraction-ring, it can generally be overcome by the patient application of gentle pressure. The edge of the placenta having been found, the fingers are gradually worked under it, and sweeping movements are made until the adhesions are broken up. The procedure may sometimes be facilitated by inserting two fingers held widely apart between the placental surface and the uterine wall, and then bringing them together like the blades of a pair of scissors. In the meantime counterpressure should be made through the abdominal walls upon the fundus, either with the operator's left hand or by an assistant. It must be insisted again that all attempts at extraction by pulling on the cord be avoided. After all the adhesions have been broken up, the margin of the placenta is carefully caught by a finger, and the whole mass lying on the palm of the hand can be forced out of the uterus. A careful examination of the membranes and of the placenta should then be made by an assistant, to learn if fragments have been left behind. It is better that, before removing his hand from the uterus, the operator make sure that the evacuation has been complete. Should fragments still remain in the uterus they should be at once removed by the hand, which may be supplemented, if need be, by the curette. These manipulations should be followed by an intra-uterine douche of normal salt solution, care being taken that no air is introduced. One or more full doses of ergot are usually advisable after the evacuation of the uterus has been completed.

CHAPTER XXXI.

THE FORCEPS.

THE obstetric forceps is essentially a pair of steel hands for grasping the fœtal head and extracting it from the birth-canal in certain emergencies in which the natural powers are inadequate. The invention is generally credited to Peter Chamberlen, an English obstetrician, in whose family it was kept a secret for four generations. The date of the latter's death was 1631; his forceps, therefore, probably came into use not far from the year 1600. The Chamberlen instrument consisted of two crossed arms articulating at the point of intersection and with blades shaped to fit the fœtal head. Though of rude construction, it was similar in pattern to the short straight forceps of the present day.[1]

In 1723, Jean Palfyn, a professor of surgery at Ghent, presented to the Academy of Science at Paris an obstetric forceps with parallel arms articulating at the lower ends. In the Palfyn, as in the Chamberlen instrument, the cephalic ends were provided with a single curve only, and that on the flat, in conformity with the shape of the head. Levret, in France, and Smellie, in England, at about the same time (1747 to 1751) introduced important improvements in the forceps, chief of which was a second curve, adapting it to the curvature of the pelvic axis. On their patterns are based the various models in use at the present day.

The obstetric forceps, however, is an invention of much greater antiquity than is generally supposed. Crude patterns of forceps are said to have been in use before the Christian era.

Description. The modern obstetric forceps consists of two interlocking crossed arms or branches. The arms are distinguished as left and right, the one passed on the left side of the pelvis being the left arm, and conversely. Each has four parts—handle, lock, shank, and blade.

The handles when the arms are locked fall together, so as to be both conveniently grasped by one hand of the operator. They are sometimes made smooth, but for a more secure hold are generally roughened or corrugated on their outer margins. A knob at the lower end adds to the security of the grasp. There is usually a transverse projection at the upper end of each handle over which a finger may be hooked when making traction. An adjustable screw or other device between the handles, to limit the compressive action of the blades, as provided in some forceps, is of doubtful utility. The regulation of the pressure upon the head during traction is a matter which is better left to the judgment of the operator. The handles are best made of metal or other material which will admit of sterilizing by heat.

The blades in the prevailing patterns of forceps have a double curve —a cephalic and a pelvic. The former adapts them to the shape of the fœtal head, the latter to that of the birth-canal.

[1] For a full account of the Chamberlen invention, the reader is referred to "The Chamberlen and the Midwifery Forceps." J. H. Aveling, London, 1882.

The cephalic curve is essential to all midwifery forceps. It is somewhat elliptical rather than circular, since the former better accommodates itself to heads of different sizes. The head curve in best models is from 15 to 18 cm., 6 to 7 inches, in length. This gives room for the largest possible cephalic seizure. When the instrument is locked, the greatest distance between the blades should be about 7.5 cm., 3 inches. With a smaller interval, blades of proper length would be too nearly straight and their hold upon the head insecure; with a greater width, the maternal soft parts would needlessly be exposed to injury.

The interval between the tips when the instrument is closed should not be less than 25 mm., 1 inch, otherwise the child's head may be injured.

It is desirable that the point of greatest divergence between the blades be not more than 7.5 cm., about 3 inches, from the tips, since the head is pressed toward the tips during traction and would be exposed to injury if the interspace at the upper part of the blades were too narrow; moreover, rotation would be hindered.

The pelvic curve of the blades should be such that when the closed instrument lies on its back, on a plane surface, the centre of the tips shall be about 8.8 cm., $3\frac{1}{2}$ inches, above the plane. A greater curvature is better suited to high and a lesser one answers for low operations. But for general use an average pelvic sweep is required. In the usual pattern the cephalic and the pelvic curves are nearly equal. A third or perineal curve, to be found in some obsolete patterns, is cumbrous and useless.

The shanks connect the handles and blades and are necessary to give the length required for high operations.

The lock in all models of forceps is based either on the Smellie or the Levret model. The former is constructed on the principle of a mortise and tenon; in the latter there is on the left or lower half a thumb-screw, or a pin surmounted by a button, and in the edge of the other half a notch into which the pin or screw fits. It is essential that the articulation be loose enough to permit locking easily, yet at the same time it should hold the arms securely in proper relation with each other. Obviously the farther the lock from the handle, the greater will be the lever-like action of the forceps in compressing the head. It should be so located as to ensure a sufficiently firm grasp of the head without undue pressure upon it. To this end it is usually placed about one-third of the way from the proximal to the distal extremity of the instrument.

In the prevailing models of forceps the blades are fenestrated. This not only conduces to lightness, but more evenly distributes the pressure. The open blades, too, take up less room than the solid. The fenestra is usually from 8 to 13 cm., $3\frac{1}{2}$ to 5 inches, in length, and is wide enough to leave a rim of 1 cm., $\frac{3}{8}$ inch, in width. By some authorities solid blades are preferred.

Short, straight forceps, so called, about two-thirds the full length and having no pelvic curve, is popular with some obstetricians for very low operations. A single, long, double-curved forceps, however, serves for all purposes.

The instrument should be made of the best-tempered steel. Some degree of elasticity is desirable, yet there must be rigidity enough to

hold the head securely. To do this, the weight should be so distributed that the shanks are strong and nearly unyielding, and the blades light, especially toward the tips. Yet it is essential that the blades have sufficient thickness to permit rounding off their edges. This is particularly important at the tips and at the margins of the fenestræ. A common fault with forceps is too great sharpness of the edges of the blades, and injuries of the scalp are of frequent occurrence in consequence of this defect.

The instrument should be kept well polished to facilitate its application. Smoothness of surface and freedom from cracks and crevices are conducive to cleanliness, but are not indispensable to asepsis if heat is employed for sterilizing.

Of the numerous models of forceps, those most used in this country are the Simpson, the Wallace, the Hodge patterns, and the Elliott, a modification of the Edinburgh instrument. In England the forceps of Simpson and of Barnes, in France that of Pajot and of Dubois, and in Germany the Naegele and the Braun forceps are commonly employed.

Function of the Forceps. The essential function of the forceps is traction. It is intended to replace or to supplement the natural expulsive forces.

FIG. 433.

The author's forceps.

Its use as a compressor, a lever, or a rotator is only exceptionally justified.

Much *compression* of the head by forceps is dangerous to the child. This is especially true when the head is seized in an oblique diameter, which is frequently the case as the instrument is usually applied.

Brain injuries, sometimes serious enough to cause the death of the fœtus, are not infrequent results of instrumental delivery. Again, compression by forceps affords little or no mechanical advantage for extraction, since in most seizures the reduction of one elongates the opposite transverse diameter of the head. Moreover, when the forceps is applied in relation with the lateral walls of the pelvis, the compression obtains in the direction in which there is usually most pelvic space and in which the reduction is least needed.

It must be remembered, too, that the more rigid the grasp of the head the more the natural mechanism is interfered with.

Moulding of the head is better trusted to the pressure of the pelvic walls, which applies compression only where it is needed, lengthens the head diameters only in the direction of the birth-canal, and inflicts a minimum of injury. The intentional use of the forceps as a compressor must be condemned. The aim should be rather to make the pressure of the blades light enough, if possible, to leave no marks upon the child.

A certain amount of compressive action, however, while undesirable, is unavoidable. It results necessarily from the grasp required to hold the handles, and it increases with the strength of the tractile force. It is evident that the risk of fœtal injury from pressure is diminished by a slow and gradual delivery with the least possible expenditure of force. The compression should not only be gentle, but also be intermitted, as a rule, at frequent intervals. A forceps with short handles, having little compressive power, lessens the danger to the fœtal head.

The *lever* action of forceps is developed by pendulum movements of the handles during traction. This is to some extent a mechanical gain, the resistance being overcome in detail. Less force is required to move down first one side of the head, then the other, than to move both together. This practice, however, is not free from danger to the maternal soft parts, and the fœtal head, and is seldom to be advised. That part of the wall of the passages about which, as a fulcrum, the lever acts, is bruised under the pressure of the blade, and injury is done to the child's head. These remarks refer especially to the lateral movements of the forceps practiced by some operators. Swaying the handles in a sagittal direction is even more objectionable, since the passages are more likely to be injured by the edges of the blades than by their broad flat surfaces. Generally a steady pull is best. Direct traction not only imitates the action of the natural powers, but it inflicts the least traumatism, and is all sufficient for the purpose.

As a *rotator*, the forceps, except in trained hands, is a dangerous instrument. Unskilful attempts at correcting malpositions with forceps may result in laceration of the passages. This is true even of the straight forceps, and especially so of instruments with the usual pelvic curve.

Faulty positions should, if possible, be reduced by manual interference before the forceps is applied. In delayed rotation it is sometimes permissible to draw the leading pole forward with the fingers. In certain conditions to be considered later, rotation may be assisted with the forceps.

When the head has not been seized primarily in the biparietal diameter, the blades should occasionally be readjusted as the head descends, and care must constantly be taken that the influence of the natural agencies for producing rotation be not resisted. Most essential is a light grasp of the forceps, with the hands near the lock, permitting the greatest possible freedom of head movements. Rightly applied, the blades will usually be kept in position by the pressure of the pelvic walls, and a strong hold upon the handles is not required to prevent slipping.

Prerequisites and Contraindications to the Use of Forceps. Before resorting to forceps, the obstetrician must satisfy himself that the following conditions are present:

1. The relative size of the head and pelvis must be such as to make the extraction safely possible for mother and child. The election of forceps is not to be based on the pelvic measurements alone. The size and plasticity of the fœtal head must be estimated. Approximate measurements of the head may be made with calipers through the abdominal wall. The presence or absence of disproportion may be determined, too, by noting whether the head has sunk into the excavation or can be made to do so with suprapubic pressure, and, if necessary, by exploration with the hand in the uterus. Well-defined osseous obstruction or much

narrowing of the canal from other causes should, as a rule, preclude the use of forceps. Its alternatives must be considered when the resistance is too great to be overcome without violent traction.

2. The head must be of nearly normal size and consistence if it is to be securely grasped by the blades. The cephalic curve of the forceps is best adapted to heads of average size. An easily compressible head is equivalent to a small head. An undeveloped, a highly macerated, or a perforated head is not suited to forceps, a firm hold being impossible. In marked hydrocephalus and in excessive development from whatever cause, not only is the resistance too great, but the divergence of the blades is excessive and their grasp insecure.

3. The child must be living and viable, except the extraction is to be an easy one. When the delivery of a dead child by forceps would be at all difficult, perforation should be substituted.

4. The position of the head must be favorable. When possible, malpositions are to be corrected by manual interference. This is not always practicable after the head has sunk deeply into the pelvis. One of the refinements of modern forceps operations is the correction of certain malpositions with that instrument.

5. It is desirable that the head shall have engaged in the brim; in other words, shall have descended far enough to bring the biparietal diameter to the level of the inlet, or that it can be crowded down to that extent by suprapubic pressure. By many authorities forceps is rejected in favor of version before engagement. When the head is free above the brim the proper application of the blades is difficult or impossible. At best the cephalic mass will be caught obliquely by one side of the occiput and the opposite side of the sinciput. In this seizure not only is the pressure of the blades dangerous to the child, but it tends to bring about premature flexion and rotation, and thus to increase the resistance. Yet the widely accepted rule, version before and forceps after engagement, is subject to exceptions. This is especially true since the introduction of the axis-traction instrument. When the waters have drained away and the fœtus is firmly invested by the uterus, version is a difficult and dangerous operation. Forceps in such conditions often serves better the interest of both patients. In general, when the conditions are favorable for an easy forceps extraction, the latter is preferable to a difficult version. No attempt to apply the blades, however, must be made till the head has been pressed down as deeply as possible and so held by an assistant.

6. The cervix must be fully dilated or easily dilatable, otherwise dangerous laceration of the lower uterine segment may result. In emergencies, recourse may be had, if necessary, to manual dilation, and sometimes multiple shallow incisions of the lower border of the cervix.

7. The membranes must be ruptured and retracted above the head. Should the membranes be caught in the grasp of the blades, the placenta may prematurely be torn partially or wholly from its attachment.

Indications for Forceps. The necessity for forceps delivery may arise from anomalies (1) of the expellent forces, (2) of the passages, (3) of the passenger, or (4) in consequence of some complication of labor independent of the mechanism.[1]

[1] The indications for forceps will be found more fully treated under Anomalies of the Mechanism of Labor.

1. *Forces at Fault.* Failure of the pains is not of itself alone an indication for forceps. The physician cannot justify himself in applying forceps to save his own time. Inertia uteri in the presence of conditions likely to jeopardize the interests of mother or child may call for instrumental delivery when simpler measures have failed. Here, as elsewhere, forceps is indicated when its dangers are less than those of delay. Important elements in the question are the strength and endurance of the mother as indicated by the force and frequency of the pulse, the presence or absence of exhausting pain, the quality and strength of the fœtal heart tones, and the probable difficulties of the operation. Impending exhaustion on the part of the mother is a frequent occasion for instrumental delivery. Just when forceps is permissible under this indication is often a delicate question requiring the exercise of critical judgment. As a rule, when the head is low down in the passages and has been arrested for a half-hour because of feeble pains, the labor should be terminated with forceps.

2. *Passages at Fault.* Marked osseous obstruction, as already observed, forbids the use of forceps. Yet moderate narrowing does not necessarily debar. The limit of contraction for forceps is variously stated by different authorities as from 8 to 9.5 cm., $3\frac{1}{4}$ to $3\frac{3}{4}$ inches. But methods of treatment in deformed pelves cannot be formulated on pelvic measurements alone. The choice of procedure must rest on the relative size of head and pelvis. Pelvic contraction is an indication for forceps only when the plasticity and size of the head permit. The field of forceps is somewhat extended by axis traction and by the Walcher posture. Yet if the child is living and viable, Cæsarean section is generally better, in the interests of both patients, than a very difficult forceps delivery.

As against version, in slight contraction, forceps has the advantage that under modern methods the pull is in the pelvic axis, more time is permitted for delivery, and the uterus is less exposed to both septic and mechanical injuries.

Tentative use of forceps is permissible in moderate obstruction in the soft parts.

3. *Passenger at Fault.* Forms of fœtal dystocia amenable to forceps are met with in occipito-posterior positions, in mento-anterior face cases, and in pelvic presentation with the breech arrested in the excavation. Rarely the instrument is superior to other methods in certain difficult extractions of the after-coming head. Evidence of fœtal exhaustion or asphyxia, pulse above 160 or below 100 to the minute, may necessitate immediate instrumental delivery. Expulsion of meconium is not so reliable an indication as the fœtal pulse-rate. Forceps is contraindicated in high transverse positions of the face, owing mainly to the danger to the child from pressure of the blades upon the vessels of the neck. The delivery of a posterior-face case as such is impossible.

4. *Accidental Complications.* Complications of labor sometimes demanding forceps are hemorrhage, prolapsus funis, rupture of the uterus, eclampsia, and all acute and chronic diseases or other complications of labor in which immediate delivery is required in the interest of mother or child, or both.

In general, the low operation is frequently justifiable on minor indications, the high operation only on major indications.

Dangers of Forceps Delivery. Accidents to which the mother is exposed, and which are not always preventable in forceps delivery, are slight contusions and lacerations of the passages. Injuries to the uterus, to the vagina, and especially to the pelvic floor are more frequent than in spontaneous labors. Most frequently torn are the cervix and the vaginal orifice, since the resistance of the soft parts is usually greatest at these points. Serious accidents are, unfortunately, common in careless and violent forceps deliveries. A cervical tear may invade the body of the uterus and enter the peritoneum. Pelvic-floor injuries not infrequently destroy the recto-vaginal septum. Owing to faulty application or to unguarded traction, the blades may slip from the head either vertically or horizontally, and be dragged abruptly through the passages. Even serious bladder wounds and perforation of the posterior vaginal fornix may occur at the hands of the careless or the inexpert. If the handles are carried too far forward or backward during traction, the vaginal walls may be cut by the tips of the blades. Misdirected traction exposes the maternal soft parts to needless injury, and even rupture of the pelvic joints is possible in violent instrumental delivery. The difficulty of extraction may be increased in the unskilful use of forceps by hindering the normal mechanism.

The danger is obviously greater the higher the head is in the pelvis, since the control of the instrument is more difficult, and injuries to the upper portion of the passages more serious. The head before it has fully engaged in the brim is imperfectly moulded, the grasp is bad, the normal head movements are impeded, and the operation not infrequently is a perilous undertaking.

The risks of forceps delivery are greater to the child than to the mother. Intracranial hemorrhage from injuries to the meningeal or cerebral vessels is not an infrequent result of compression in difficult, and this sometimes occurs in easy-forceps extractions. Injurious pressure may arise from rapidly dragging an unmoulded head through the pelvis as well as directly from too forcible grasp of the blades. A considerable fœtal mortality is attributable to these injuries, and permanent mental and physical infirmities may result in children who survive them. Hemiplegia, idiocy from cerebral atrophy, psychical disorders, and even epilepsy in later life are believed to be possible consequences of these lesions. The region of the lower anterior angle of the parietal bone is the most vulnerable one.

When the cord is coiled about the child's neck it is exposed to pressure from the tips of the forceps blades and fatal asphyxia may ensue. Facial paralysis results most frequently from compression of the facial nerve-trunks in oblique seizures of the head, but may occur from the pressure of an intracranial blood-clot. The former injuries usually are unimportant, the paralysis disappearing within a few days. Injuries to the brachial plexus have occurred in forceps operations, but probably from stretching the nerve-trunks rather than from pressure effects. Abrasions, indentations, lacerations, and contusions of the scalp, face, and eyeballs are common in bad instrumental deliveries. Anything more than slight or transient markings must be regarded as a reproach upon the skill of the operator. Deep indentations of the skull or fracture of the cranial bones can result only from culpable ignorance or carelessness.

Fatal asphyxia is far too common after births terminated with forceps. This may result from premature efforts at respiration, provoked by peripheral irritation, or from the inhibitory effect of brain compression on the cardiac movements through irritation of the vagus. When head and pelvis are proportionate, the skilful and timely use of forceps should diminish rather than increase the fœtal mortality.

Preparation for the Forceps Operation. The bladder and the rectum are to be emptied; either of these viscera if distended may suffer serious injury from the forceps. The cleanliness of the operation may be promoted by thoroughly washing out the lower bowel as a preliminary measure.

The quality and the frequency of the fœtal heart tones should be noted and should be listened for at intervals during delivery. Anæsthesia to the surgical degree is generally advisable, and for this purpose ether, as a rule, is to be preferred. In low operations mere obstetric anæsthesia often suffices, or none at all may be necessary. In all prolonged and difficult extractions complete narcosis is required. The administration of the anæsthetic should, if possible, be entrusted only to a skilled medical assistant, and should be managed in accordance with the usual rules of surgical practice.

The abdomen, the thighs, and especially the external genitals are rendered as nearly aseptic as possible. Particular care is given to the cleansing of the vulva and its immediate surroundings. If the vagina is healthy and has not been exposed to unclean contact during the labor or for some hours before, no internal antisepsis is required. When the vagina or cervix is diseased or there is reason to believe they have been infected, the passages should be prepared with the same care as are the external genitals. They are cleansed with soft soap and hot water, with the aid of general friction, for five minutes, care being taken to prevent abrasions. The friction is best applied with the fingers or with a soft cotton ball held in the grasp of a suitable forceps. A sublimate douche 1 : 4000, or other equally active antiseptic solution, is then to be employed for the same length of time, the friction being continued. The lubrication of the parts may, if necessary, be restored by the plentiful use of sterilized glycerin or vaseline. In hospitals it is a common antiseptic precaution to cover the legs and feet with sterilized leggings or drawers. Wrapping them in aseptic sheets suffices, and this method is recommended in family practice where the leggings are not usually available.

The operator's hands and forearms are to be prepared as for a major surgical operation. A sterilized operating-gown or, in the absence of this, an apron or a sheet should protect the physician's clothing against contact with his hands. The instrument is best sterilized by boiling. It may be wrapped securely in a towel before sterilizing, and so kept till wanted for use. A basin containing bichloride solution (1 : 2000) or other suitable antiseptic and several squares of cheese-cloth should be provided. The antiseptic solution serves for rinsing the hands as required and for cleansing the external genitals of the discharges. An ounce or two of glycerin or of vaseline which has been sterilized by heat may be found useful as a lubricant for hands and instrument.

The operation is best conducted on a firm table which has been properly cleansed, dressed, and covered with a surgically clean sheet. A

high or otherwise difficult operation should not be undertaken on the bed. When the patient is to be delivered on the bed, the mattress is protected with a rubber sheet. The bed-linen and the patient's clothing must be as nearly aseptic as possible.

A suitable basin or slop-jar is placed on the floor at the edge of the bed or table to receive the discharges. A rug or a table oil-cloth spread under it prevents soiling the carpet.

Indispensable to a successful and safe forceps delivery is an exact knowledge of the position of the fœtal head. In case of the slightest doubt or any possibility of error, the diagnosis of position should be confirmed by passing the hand, if necessary, into the uterus. Finding an ear may suffice for determining the fœtal position, but, as a rule, the entire head should be examined. This examination can best be made after the patient has been placed under the anæsthetic. With the aid of anæsthesia and with the hand in the uterus, it is possible in every case to know with absolute certainty the position of the head.

The cervix must be fully dilated or so soft and yielding as to permit the passage of the head without risk of tearing. Dilation may be completed, if necessary, with the hand or by means of a water-bag, and even multiple incisions to the depth of ½ inch are permissible in emergencies requiring prompt delivery.

Posture of the Patient. In this country, in France, and in Germany the position generally preferred for ordinary forceps delivery is the partial or complete lithotomy position. The patient is placed on her back, with the thighs and the legs flexed and the knees held apart, the hips extending over the side of the bed, or in a similar position on a firm table. One assistant on each side is usually necessary for holding the limbs. In the absence of assistants, a Robb or Buckmaster leg-holder or a sheet-sling may be utilized for the purpose.

The left lateral position, usually adopted in England for forceps delivery and known as the English position, is most unsuitable.

Walcher's Position. It is well known that the sacrum, especially in the later months of pregnancy, is capable of a slight nutatory motion on a transverse axis passing through its second vertebra. Walcher, in 1889, called attention to the importance of utilizing the mobility of the sacro-iliac joints in difficult labor. The sacral promonotory lies in a plane above the axis of rotation and in front of it. The promontory, therefore, moves forward and backward, according to the changing inclination of the pelvis in different postures of the body, and the tip of the sacrum, of course, moves in reverse direction. When the woman lies in the lithotomy position, the thighs being strongly flexed upon the abdomen, the conjugate diameter of the pelvis is shortened; when placed in the dorsal position with the hips close to the edge of the table and the lower extremities hanging, that diameter is lengthened. The latter posture is known as Walcher's position. (See Plate XI.) The gain in the conjugate on changing from the lithotomy to the Walcher position is variously estimated at from 5 to 13 mm. In a series of observations made by the writer, the increment was, in the cadaver of the non-puerperal subject, 3 mm., and in the living woman within two weeks after labor, from 5 to 7 mm. The maximum increase in labor does not exceed 13 mm. The gain, though small, may be utilized to advantage in moderate

disproportion between head and pelvis. In difficult extractions the patient should be placed with the thighs in full extension till the largest circumference of the head has passed the brim. On the other hand, the dorsal recumbent posture, thighs moderately flexed and knees held apart, and especially the extreme lithotomy position is better during the extraction of the head through the outlet of the bony pelvis.

The Operation. The operation is spoken of as high, low, or medium, according to the situation of the head in the passages; it is *high* when the head is barely engaged in the brim, *low* when it rests well down on the pelvic floor, and *medium* in intermediate situations. These operations differ in the extent and character of the manipulations involved, not only by reason of the changing direction of the birth-canal, but also because of the varying positions of the fœtal head at different stages of descent. Low forceps delivery is a comparatively simple undertaking, especially if the cervix has retracted above the head; the high operation is one demanding the utmost skill and tact.

FIG. 434

Cephalic application of forceps over the parietal eminences. (FARABEUF and VARNIER.)

THE APPLICATION of the forceps may be cephalic or pelvic. In the former, the head is seized transversely, the blades resting over the parietal eminences, the long axis of the blades lying parallel with the occipito-mental diameter of the head (Fig. 434); in the latter, the blades are applied in relation with the sides of the pelvis without reference to the head.

Application to the sides of the head has the following advantages: The grasp is symmetrical, the blades fit better, they do less injury to the head, the normal mechanism is less disturbed.

When the blades are applied to the sides of the pelvis, the head is usually caught obliquely; in high applications the grasp falls over one frontal bone and the opposite side of the occipital, a direction in which compression is especially harmful and the grasp likely to be insecure.

On the other hand, the pelvic application of forceps is simpler and easier than the cephalic, and in inexperienced hands less endangers the soft parts of the mother; if the handles are held lightly and the traction is intermittent, the pressure on the head usually is well borne.

In low operations, rotation being complete or nearly so, application to the sides of the pelvis brings the blades at the same time in relation with the sides of the head. It is only in high or medium cases that the choice of methods must be considered. In high operations the difficulty and danger of the cephalic application are, as a rule, too great to justify the inexperienced operator in attempting it. On the whole, the beginner will do well to content himself with the pelvic application of forceps. The expert will best serve the interests of both patients by electing the cephalic. When, however, it becomes necessary to bring the head down through the brim, the blades are to be adjusted first in a transverse diameter of the pelvis; after the head has entered the excavation, the instrument may be readjusted or removed and reapplied over the parietal bones.

Steps of the Operation. The operation comprises four steps: The introduction of the first blade; the introduction of the second blade; locking the forceps; the extraction of the fœtus.

Application with reference to the pelvis will first be considered. It will be assumed that the head is in an anterior position.

1. Pelvic Application. (*a*) *Introduction of the First Blade.*—If hands and instrument are wet with the antiseptic solution, no other lubricant, as a rule, is required; should any be needed, vaseline or glycerine, previously sterilized by heat, may be used. The latter is more cleanly.

For convenience in locking, the left, since it is the lower arm of the forceps, is usually passed first. The operator sits or stands, as may be most convenient. The patient in position and all preparations complete, he introduces two or more fingers of the right hand into the vagina with their volar surfaces facing his left. They are pushed upward and backward between the head and the left wall of the passages. If the head is still in the uterus, care will be required to make sure that the fingers are passed with the cervix. The finger-tips are carried as far as they will go readily, and the cervix is held well outward, away from the head. The nearer the head to the vulvar orifice, the greater the difficulty and the less the need of pushing the guiding fingers deeply in the pelvis. The left branch of the forceps is now taken in the left hand and the blade is introduced, the palmar surface of the hand in the passages serving as a guide. The arm of the forceps is at first grasped near the lock and is held lightly between the thumb and finger and in a nearly vertical direction (Fig. 435). As the blade approaches the head, the handle may be held in the full hand. The instrument is pushed gently on in the direction of the passage till it reaches the head. From this point the course of the blade is that of a spiral; it must follow both the pelvic and the cranial curves. After it has passed beyond the reach of the fingers, it is guided by hugging the head with the tip. Urged cautiously

along, it finds its own way, moving in the direction of least resistance. No force is necessary or permissible. Should any obstacle be met, it must not be overcome by increasing the pressure; the blade should be partially withdrawn and its direction slightly altered till it slips easily into place. It is carried well up till the tip barely overreaches the head. Should a uterine contraction occur, the manipulations should be suspended till it ceases. Usually under anæsthesia the pains are in abeyance.

Fig. 435.

Application of first blade of forceps. (Zweifel.)

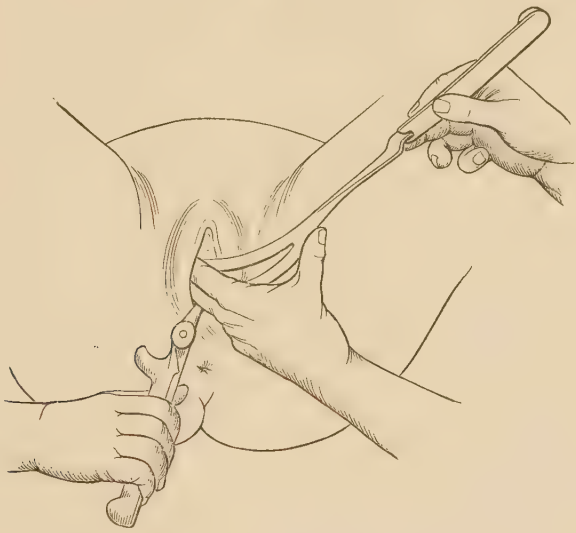
(*b*) *Introduction of the Second Blade.* The right half of the forceps is held in the right hand and the blade passed on the left hand as a guide, in a manner entirely similar to that already described for the first blade. The handle of the first arm may, meantime, be held by an assistant, or be left to itself (Fig. 436). The application of the second blade, while not so easy as the first, is not, as a rule, difficult.

(*c*) *Adjustment and Locking.* The operator now seizes one handle in each hand, the thumbs being extended along the upper surface. If the blades are properly applied the two halves of the instrument will fall into symmetrical positions and will lock easily. If the handles do not face each other, push them well back against the perineum; should one be higher in the pelvis than the other, push the lower one gently up. In high operations it will always be necessary to press the handles as far back as the perineum will permit. The locking must never be forced. If difficulty is still encountered, the blades should be removed or partially withdrawn and repassed. With a good seizure, the head being of normal size, the handles, while they are not in contact, will not be far apart. A common mistake in the application of forceps consists in failing to pass the blades far enough. The aim should be to bring the head well within the cranial curvature of the instrument. Care must be taken that the grasp is not too far forward or backward with relation

to the pelvic axis, and that it does not include a loop of the cord. As the arms are locked a finger is swept around the shanks to prevent catching the labia or vulvar hairs between them.

2. Cephalic Application. It is assumed that the head has passed the brim or is in the excavation. The left blade usually is passed first. The guiding fingers are carried up along the side of the head as far as they can reach, finding the place where there is most room. The blade is then introduced, and, with the aid of one finger hooked under the front or the back rim of the fenestra, it is then urged gently sidewise into position over the parietal eminence. With changed hands the remaining blade is applied in like manner over the opposite parietal bone. The internal fingers, pushed up as far as possible between the side of the head and the sacro-iliac ligament, guide the blade to its destination. Should it have been necessary to pass the right blade first, the handles must be readjusted for locking.

Fig. 436.



Application of second blade. (Zweifel.)

If the forceps is in proper relation to the head it will lock readily. It will now be seen that the handles do not lie in the median plane, as they do when applied in relation with the sides of the pelvis. In high applications they will be found nearly or quite in line with the oblique diameter of the pelvic brim, facing strongly to one side. When the head is deeper in the pelvis they look more nearly forward.

(*d*) *Extraction.* The forceps being locked, the operator examines to assure himself finally that the blades are in proper relation with the head. The force and frequency of the fœtal heart are noted and are listened for at intervals during delivery.

In easy extractions the pull is applied with one hand while a finger of the other is held against the head to give warning should the instrument

slip. When more force is required, both hands are used for traction, and examinations are made in the intervals.

The tractions, like the natural pains, should be intermittent. They should continue for about one minute, and the intervals may be one or two minutes. During the intervals, the forceps is unlocked to relieve the head from pressure. The line of traction must be such that the blades are kept constantly in the axis of the birth-canal.

(*a*) *In Low Operations.* In low operations the pelvic application of the forceps brings the blades over the sides of the fœtal head. The delivery is effected for the most part or wholly under ocular inspection. With the head well down on the pelvic floor and in anterior position, but little tractile force is needed, and the risks of either fœtal or maternal injuries are insignificant. The forceps is grasped with one hand near the lock, the first and second fingers hooking over the projecting shoulders at the upper ends of the handles. The least possible compression is thus exerted upon the head. In many cases none is required to maintain the grasp. The walls of the birth-canal, as a rule, make sufficient pressure to keep the blades in place when the seizure is good and little tractile force is employed. The palm of the hand may be turned up or down.

The extraction of the head may or may not be completed with the forceps. The thickness of the blades is too small to make any appreciable difference in the distension of the pelvic floor, yet too great strain may be brought upon the resisting soft parts by misdirection of the tractile force or by disturbance of the normal mechanism of expulsion. Injury may inadvertently be done by dragging the head too heavily against the pelvic floor or by too rapid extension. If preferred, therefore, the forceps may be removed when the head has descended so far that it no longer recedes in the intervals between tractions. The head is then expelled easily by light pressure applied from behind, through the perineum. With the fingers of one hand upon the occiput and with the other hand laid flat upon the bulging surface well back of the posterior vulvar commissure, thumb to one side and fingers to the other side of the genital fissure, the advance of the head is perfectly under control. On no account are the fingers to be introduced into the rectum for the purpose of shelling out the head. The practice is unnecessary and is incompatible with asepsis.

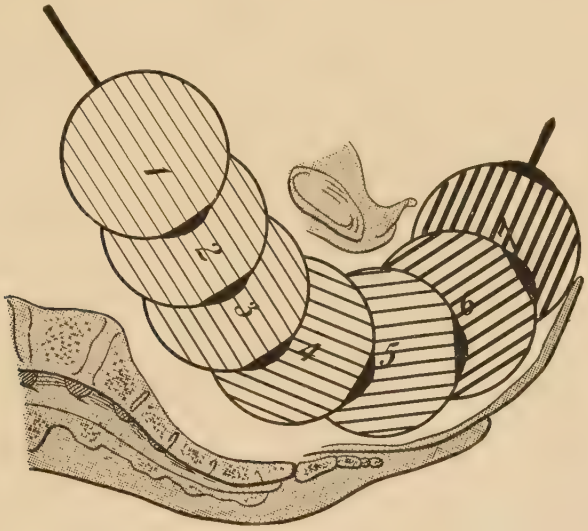
The forceps blades are removed in the reverse order of their application. Two fingers of one hand are applied over the anterior edge of the blade, just within the vulva, to protect the maternal soft parts. As the blade is withdrawn, the handle is gradually swept well up over the opposite groin. Should an obstacle be encountered, the blade must not be extracted forcibly. If the obstruction cannot be overcome by slightly changing the direction of the blade, the latter may be left in place till the head is delivered.

If delivery is completed with forceps, the natural mechanism of expulsion must be followed closely. The head is drawn down till the nucha is well under the pubic arch. Then by an upward movement of the handles, the forehead, the face, and the chin are made to sweep in succession over the vulvar edge. (Fig. 437.)

The handles may be held forward during the perineal stage of the operation as far as possible without bruising the soft parts between the

anterior edges of the blades and the ischio-pubic rami. This will necessitate carrying the handles more and more forward and upward as the head descends, till at the moment when it escapes they are almost in contact with the mother's abdomen. After the pelvic floor begins to bulge the instrument is held by the shanks near the lock with the radial edge of the hand up.

FIG. 437.



Showing the normal course of the head in its descent through the birth-canal. (FARABEUF and VARNIER.)

If in doubt as to the extent to which the handles should be swept forward, let go the handles and observe their direction. If the blades are in proper relation to the head, the direction which the handles assume when left to themselves will be that in which they should be held during the next traction.

During the perineal stage of the operation the head should be pressed well up into the pubic arch. The perineum and anal orifice are covered with a sterile towel. Over this the hand is held broadly across the bulging pelvic floor, the thumb lying along one side and the fingers along the other side of the vulva. Firm pressure is made toward the pubic arch during traction. This manipulation aids materially in preventing pelvic-floor injuries by relieving the fascial structures of the floor of excessive strain during extraction of the head.

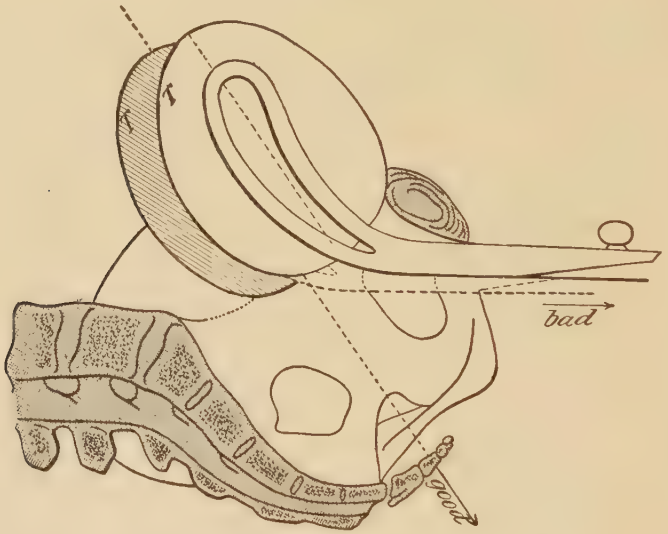
In artificial as in spontaneous births time is an important element in the prevention of perineal injuries. The extraction must be slow and gradual to permit the pelvic floor to stretch. In primiparæ, as a rule, from twenty minutes to a half hour will be required for this stage of the delivery, and little less in most other cases. Preliminary manual dilation of the vaginal orifice may be practiced when the orifice is small or the pelvic floor rigid.

(*b*) *In High Operations.* If the ordinary forceps is used, both hands usually are required for traction. If a straight pull upon the handles is to

be employed they may face each other with the handles flatwise between them. The first two fingers of one hand are hooked over the transverse projections and upon these fingers rest the corresponding ones of the other hand. The remaining fingers of one hand encircle the handles, holding them firmly enough only to prevent the blades from slipping. When the instrument is rightly applied little or no compression is necessary.

But to act to the best advantage the tractile force must be applied as nearly as possible in the axis of the birth-canal. A straight pull on the handles wastes a part of the force by dragging the head against the

FIG. 438.



Head at superior strait; right and wrong traction. (FARABEUF.)

anterior pelvic wall (Fig. 438), and the misdirected force is not only lost, but is mischievous. It increases the resistance and adds to the risk of both maternal and fœtal injuries. Yet with an instrument of moderate pelvic curve the disadvantage of direct traction on the handles is insignificant in medium or low forceps deliveries.

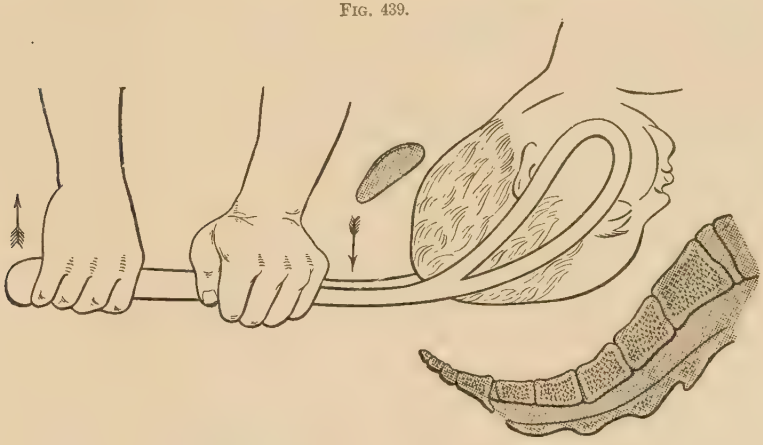
Axis traction is possible with the common forceps by Pajot's (Saxtorph's) manœuvre, which is executed as follows: The handles are held lightly with one hand near the lock, to avoid much compression, and the other hand is applied upon the shanks, near the vulva. Pressing downward with the hand on the shanks, while the other pulls upward at the handles, the two forces may be so balanced that the resultant shall act in the line of descent. If the operator stands by the bed or table, the hands are applied above the instrument with the palmar surfaces down (Fig. 439); sitting, the hands grasp the forceps palms upward (Fig. 440). The mechanical principal involved is also set forth in Fig. 441.

Line of Pull. A straight line passing through the umbilicus and the tip of the coccyx is practically the line of descent till the head reaches the pelvic floor; this line is parallel with the posterior surface of the sym-

physis pubis, which may be taken as the guide. For greater accuracy, the direction may sweep very slightly backward in conformity with the curvature of the sacrum.

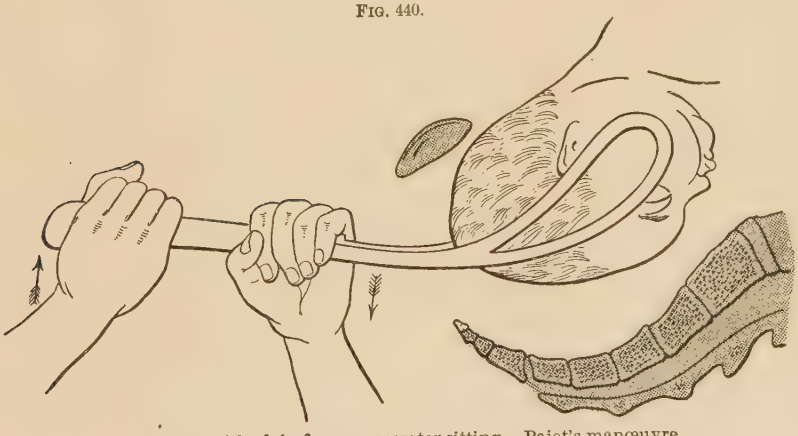
As soon as the pelvic floor begins to bulge under pressure of the advancing head, the line of direction turns somewhat abruptly forward.

FIG. 439.



Axis traction with plain forceps, operator standing. Pajot's manœuvre.

FIG. 440.



Axis traction with plain forceps, operator sitting. Pajot's manœuvre.

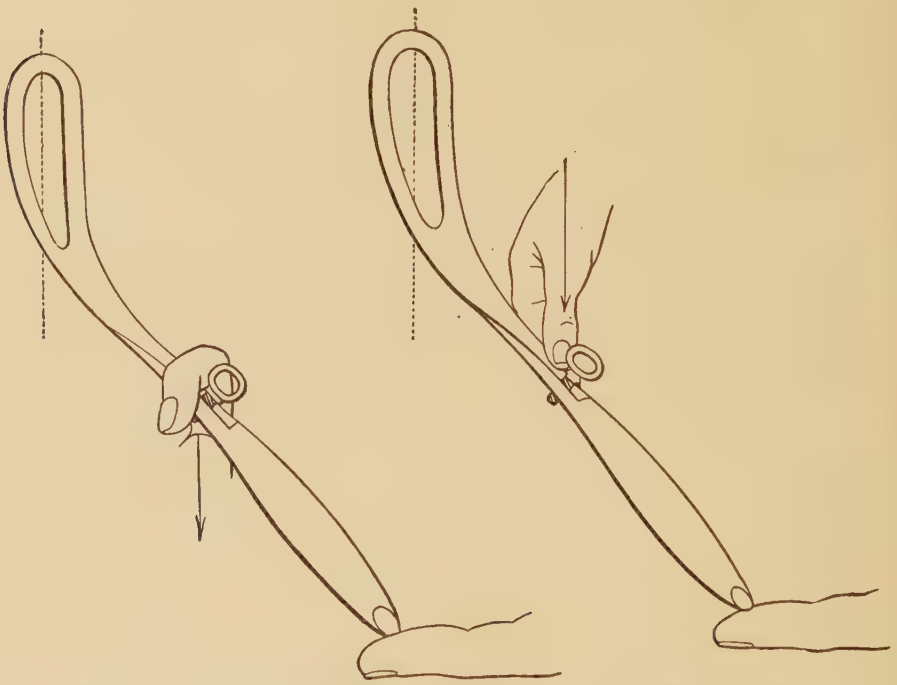
From this point, the technique does not differ from that of the low operation already described.

The Amount of Tractile Force should not exceed seventy pounds; in the Pajot method it can scarcely reach that limit at the hands of most operators. In the writer's experience, the strength of pull, as measured by a dynamometer attached to an axis-traction instrument, has not in the most difficult of justifiable forceps deliveries exceeded seventy pounds. In a properly conducted forceps operation the force employed will seldom be more than twenty-five or thirty pounds, and it will very rarely amount to fifty pounds.

Traction should be made with the arms only. Bracing the feet and pulling with the weight of the body is neither necessary nor permissible. The beginning traction should be tentative to make sure that the head is properly in the grasp of the blades and that no unusual obstacle or difficulty is present.

Since the high operation must be conducted under full anæsthesia, no aid is to be expected from the natural pains. Well-directed abdominal

FIG. 441.



Showing the mechanics of axis traction with plain forceps. (FARABEUF and VARNIER.)

pressure, however, at the hands of a skilled assistant is an efficient help. This may be continued with advantage till the head is well down on the pelvic floor.

The rule of a pull and a pause, of about one minute each, should be observed, and the forceps be unlocked in the intervals between tractions to relax the pressure upon the head.

In all high operations, and especially in pelvic distortion, where we have no reliable anatomical guides to the axis of the bony canal, the axis-traction instrument, which itself points out the way and at the same time permits the greatest possible freedom of head movements, is far superior to plain forceps, and should be preferred.

General Rules. The normal mechanism of labor must be strictly observed throughout the descent. As soon as the equator of the head has passed the brim, rotation begins. While the forward movement of the occiput must not be forced, it may be favored. When the blades have been applied in relation with the sides of the pelvis, they must be readjusted as the head rotates in the course of its descent.

While the head is passing the superior strait the possible advantage of the Walcher position should be borne in mind. Traction should be moderate, permitting time for moulding of the head. As already stated, the cervix, as a rule, should be fully dilated, manually if need be, before the application of forceps. The tension of the cervical ring must be watched during traction, and time must be allowed for it to yield gradually should dilatation prove not to have been complete. If the cervix is drawn down to the vulva it may be pushed back over the head gently with the fingers of one hand, while moderate traction upon the handles of the instrument is applied with the other.

(*c*) *In Medium Operations.* The method of procedure in cases intermediate between the high and the low operation scarcely needs discussion. It should be remembered that in the typical relation of head to pelvis the sagittal suture approximates the antero-posterior diameter of the pelvis only when the head has reached the outlet of the soft parts. The higher in the pelvis, the more oblique will be the seizure of the head in the pelvic application of the instrument.

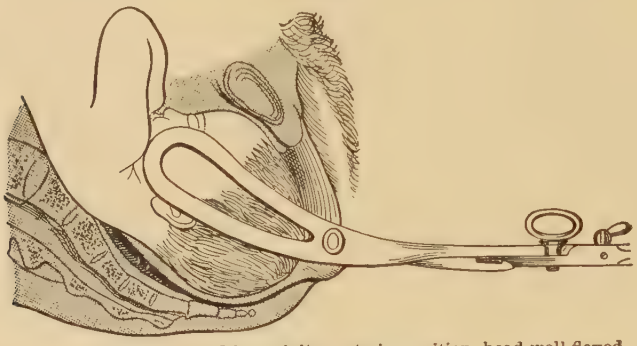
Forceps in Occipito-posterior Positions. In posterior positions of the vertex before engagement forceps is inadmissible. It is the writer's practice, if the head is movable at the brim or can readily be pushed up, to rotate not the head alone but the entire fœtus into dorso-anterior position. Before rupture of the membranes this is frequently possible by external manipulation. If the waters have escaped one hand is carried into the uterus to the posterior shoulder, which is swept outward away from the median line, the anterior shoulder at the same time being urged inward toward the median line by the external hand over the abdomen. This is done with the aid of full anæsthesia. After bringing the occiput to the front the head is crowded into the pelvic brim by external pressure, and the forceps then applied, if necessary.

If the head has engaged too firmly to permit correction of the malposition, forceps should be withheld as long as possible. In general, rotation may be awaited safely so long as the pains are good, the pelvic floor resilient, and the conditions of both patients such as to justify delay. Except in extreme emergencies, simple measures should be exhausted before resorting to instrumental delivery. The operation is more difficult and is much more dangerous to mother and child than when the occiput confronts the anterior half of the pelvis, and must not be lightly undertaken. When forceps must be used, application to the sides of the head is desirable, yet it is more difficult than in anterior positions. The cephalic application, however, is inadvisable before the head has descended into the cavity. Generally, it will be found best to introduce the anterior blade first, whether that be the left or the right one. A moderately firm grasp will be required to prevent slipping (Fig. 403).

In occipito-posterior positions the arrest of the head frequently means imperfect flexion. To bring down the occiput, when flexion is incomplete, the line of traction should be somewhat in front of the pelvic axis till the forehead clears the pubic arch (Fig. 404). The occipital pole may then be lifted over the vulvar edge with the forceps. The writer, however, prefers to remove the forceps when the head has reached the vulvar outlet and to complete the delivery by manual measures. In most

cases it is possible after the head is well in the grasp of the vulvo-vaginal ring to rotate the occiput to the front by manual interference. Under backward pressure with the fingers of one hand against the anterior temple, rotation usually takes place with the utmost facility. The

FIG. 442.



Relation of forceps to head in occipito-posterior position, head well flexed. (FARABEUF and VARNIER.)

posterior pole of the head may at the same time be drawn forward with the other hand, if necessary. Even should the rotation be difficult there is little risk of doing harm to either mother or child by properly directed manual efforts. It is commonly stated that the fœtal head cannot be

FIG. 443.

Occipito-posterior position, flexion incomplete. Forceps applied over mastoid and pulling forward to increase flexion. (FARABEUF and VARNIER.)

turned for more than a quarter circle without danger of injury to the atlo-axial articulation. But Tarnier has called attention to the fact that the torsion is distributed along the entire upper portion of the spinal column, and may safely be carried, therefore, beyond a quarter circle. Exaggerated rotation, he thinks, is less dangerous than the excessive flexion necessary to delivery in the posterior position of the occiput.

When other measures fail, forceps in skilled hands is invaluable for rotating the head when arrested after it has passed the brim. By this procedure, first proposed by Scanzoni, a serious complication of labor has been robbed of its terrors. It is essential that the blades be applied to

the sides of the head, and that the tips of the blades be kept in the axis of the birth-canal during the entire rotation. To this end, if the forceps has a pelvic curve, the handles must be carried well over toward that thigh which confronts the concavity of the instrument. The rotation is made through not more than 90 degrees at one effort. Time is then allowed for the trunk to rotate with the aid, if needed, of external manipulation. Rotation having been effected, the forceps is removed and reapplied with the concavity of the blades to the front. As a rotator, the straight forceps may be safer than one with the usual pelvic curve.

Should rotation fail, which is rarely possible, the delivery is completed with forceps, in accordance with the usual mechanism of persistent occipito-posterior positions. The occiput is drawn well forward and lifted over the posterior vulvar commissure. The head is then delivered by a movement of extension about the nucha as a pivotal point.

Forceps in Face Presentation. In mento-posterior face cases, forceps is contraindicated. In an impacted face position, symphysiotomy or hebotomy may be considered if the child is living and viable, otherwise the head should be perforated.

In low mento-anterior face positions forceps delivery presents no special difficulty. Judicious attempts at manual rotation are often successful. Cautious rotation with forceps may be tried when other methods fail. Extension must be maintained and the mechanism of natural delivery be carefully followed. The only safe application is to the sides of the head, and care is necessary to secure a firm hold along the mento-occipital diameter, reaching well back to prevent slipping. Any other seizure endangers the child by pressure upon the neck and, moreover, is insecure. Traction is made horizontally till the chin is brought well under the pubic arch; then by raising the handles, the face, the vertex, and the occiput are successively swept over the perineum.

Forceps to Breech. Forceps, while not well adapted to the breech, is a valuable measure in certain cases of this presentation. When the pelvic end of the fœtal ovoid has so far engaged that a foot cannot be brought down, yet has not sunk deeply enough in the excavation to permit the successful use of finger or fillet, the forceps may be tried. The axis-traction instrument is to be preferred, especially in high operations. The best application is that of Ollivier, one blade resting over the sacrum and one ilium, the other over the posterior surface of the opposite thigh.

Manual rotation is sometimes possible when the position is not primarily suitable for a satisfactory seizure. When the breech is fixed transversely in the pelvis the blades may be placed over the trochanters. Application over the iliac crests is recommended by some writers, but these bony prominences are compressible, and the tips of the blades are liable to injure the abdomen. In all applications to the breech it is difficult so to regulate the grasp as to make the hold secure, and at the same time to prevent injurious pressure. The amount of tractile force should be kept at a minimum by pulling only during the pains and by the help of external pressure applied by an assistant over the fundus. If the child is dead, a firm grasp is permissible.

Forceps to After-coming Head. In all cases of breech extraction, the forceps should be in readiness for instant use in cases of difficulty in extracting the after-coming head. While seldom necessary, it cannot be

denied that forceps in head-last births is the most effective of all methods of delivering the head. The application is attended with no difficulty. The body of the child should be held up over the abdomen of the mother and the blades passed beneath the fœtal trunk (Fig. 444). Forceps to the after-coming head is not permissible when the head is not engaged or cannot be forced well into the pelvic brim.

FIG. 444.

Extraction of the after-coming head with forceps.

Head Separated from the Trunk. It may become necessary to extract the detached head from the uterus after decapitation or when the head has been torn from the trunk and left behind through unskilful traction upon the trunk in breech births. Frequently, with the aid of suprapubic pressure, the delivery is possible without resort to instruments. In forceps as in manual extraction, the chin in such cases should first be brought down and so held during the delivery, to keep the long diameter of the head in the axis of the uterus.

AXIS-TRACTION FORCEPS.

An obvious disadvantage of the classical forceps is the fact that in pulling in line with the handles the tractile force is not applied in the parturient axis. The head as it is drawn down is dragged against the anterior soft parts of the birth-canal (Fig. 438).

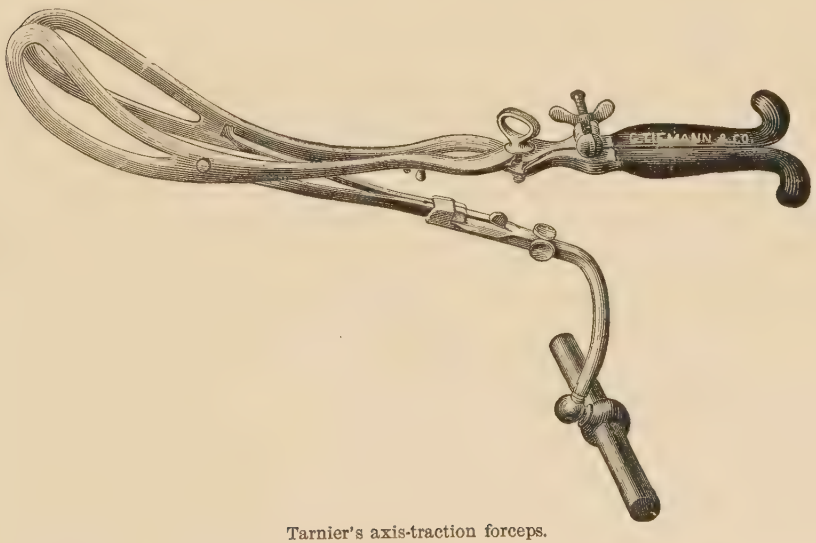
By Pajot's manœuvre this fault in the ordinary forceps is obviated in part but not wholly, since it is impossible to estimate precisely the direction of the pelvic axis. Several devices have been proposed with a view to accomplish axis traction. Among these may be mentioned the forceps of Hermann (1844), in which the Pajot principle was carried out by a rod attached by a movable joint to the shank and used for pulling from below or pushing from above; that of Galabin, with the handles bent backward, Hubert's forceps, in the latest pattern of which (1866) the traction is made at the end of a rigid arm projecting backward at a right angle from the shanks, and Poullet's forceps, in which the pull is applied by means of tapes passed through apertures in the blades. All these instru-

ments are open to the objection that the line of pull is left to the judgment of the operator, and they do not, therefore, ensure precision in the right line of traction.

Another and perhaps a more serious defect in the common forceps is the fact that its rigid grasp interferes to a greater or less extent with the natural movements of the head. In this particular, as in the line of pull, it is in high operations that the ordinary instrument is at its greatest disadvantage. This fault, like the first, loses much of its importance at the hands of a skilful operator, yet is by no means wholly obviated even by the most expert management. After the head has reached the pelvic floor the mechanism is less complex and its regulation more easily at command of the operator.

In 1877 Tarnier, of Paris, gave to the profession an axis-traction forceps which, as since modified, has been widely adopted. In this instrument each arm, which does not differ essentially from the ordinary pattern, is provided with a slender traction-rod which is attached by a movable joint to the heel of the blade and terminates below near the lock. The-

FIG. 445.



Tarnier's axis-traction forceps.

oretically the rods should pull from the centres of the blades, since traction from these points would involve no directive action on the head. But to place the traction studs at the centre of the blade it would be necessary to insert in the fenestra a transverse bar, which would be likely to injure the head. The stud is, therefore, located at the heel of the blade. This construction, while not theoretically perfect, practically answers all requirements. The rod runs along the under edge of the shank, and when not in use is held in place by a pin against which it rests at its lower end. After the blades are applied and the instrument locked the necessary compression is maintained by means of a fixation screw attached to the handles. The use of the fixation screw, however, is

seldom necessary. The lower ends of the traction rods are released from the shanks and are locked to a traction handle. The latter consists of a single rod bent strongly backward and armed at its lower end with a cross-bar for convenience in pulling. The construction of the instrument is such that when the traction rods are held about $\frac{2}{5}$ inch away from the forceps shanks the line of pull will be in the axis of the blades, and, therefore, in that of the birth-canal. A movable joint at the cross-bar and the one at the attachment to the blades permit the utmost freedom of head movements. The blades when properly applied maintain their normal relation to the axis of the passages as the head descends. The application handles change their direction with the changing direction of the blades in the course of the descent, and thus serve as an index of the right line of traction.

Reynolds and others have devised traction rods, to be attached to ordinary forceps; but these appliances only approximately accomplish their object. Lusk's axis-traction forceps differ from the Tarnier model mainly in being lighter. In the Simpson pattern the traction apparatus

FIG. 446.

Mechanics of axis-traction forceps.

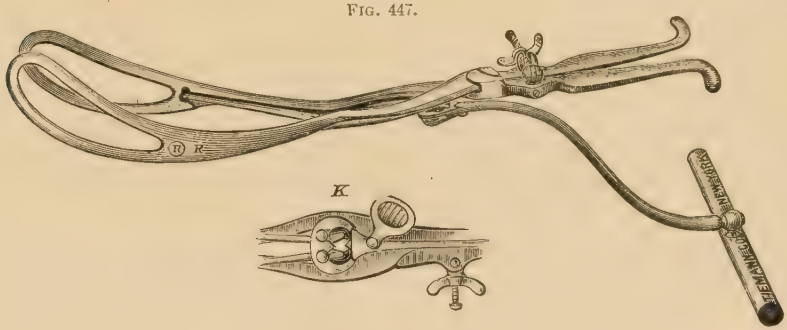
Pulling at the traction-handle in the direction indicated by the lower arrow, the line of traction is in the axis of the blades, as shown by the upper arrow. (FARABEUF and VARNIER.)

is attached to the ordinary Simpson forceps. Milne Murray has made a special study of the principle of axis traction from a mathematical standpoint, and has enunciated a formula for the construction of the instrument. The axis-traction forceps of the writer is constructed on the formula of Murray, but is much lighter than the prevailing patterns (Fig. 447). A model used for several years weighs, without traction rods and handle, only sixteen ounces, yet has proved equal to all requirements.

The superiority of axis-traction forceps over the simple instrument, as

commonly accepted, depends upon two things: 1. Pulling as it does directly in the line of descent all the tractile force is utilized. 2. The blades being free to follow the natural movements of the head, the normal mechanism is not disturbed. Delivery is thus accomplished with the least possible amount of traction and with a minimum of maternal and fœtal injuries. The facility with which the head may be brought down with axis-traction forceps is often in striking contrast with the difficulty frequently encountered in delivery with the classical instrument. For these reasons the

FIG. 447.



Jewett's axis-traction forceps.
K. Lock for attaching traction-handle to rods.

axis-traction instrument should be adopted for all high or medium forceps deliveries.

Most operators disuse the special traction after the presenting part becomes visible at the vulvar orifice, completing the delivery as with simple forceps.

Murray, Nagel, and others have called attention to the fact that the axis-traction principle holds good in low as in high operations. While its advantage is not so great after the head is well down on the pelvic floor, it obtains in some degree till the head is born.

If the obstetrician is equipped with a good axis-traction forceps he needs no other. The axis-traction instrument is not only sufficient, but is best for all possible requirements.

Operation. The blades are best applied with the patient in the usual dorsal recumbent position. For extraction, she may lie on the back if the operation is conducted on a table; on a low bed she should be turned upon the left side. Walcher's position should be utilized in difficult extractions. After the forceps has been adjusted and locked, the application handles are grasped with one hand firmly enough barely to bring the blades in contact with the head. The fixation screw is then set to maintain the pressure thus obtained, but must not be used for compression, owing to the difficulty of correctly estimating the amount of force applied. The use of the screw, however, is not usually necessary. When employed it should be released in the intervals between tractions.

The pull is applied at the traction bar with one hand, while a finger of the other is held against the head to give warning, should the blades begin to slip. Very rarely will it be necessary to use both hands for pulling.

The traction rods must not be allowed to rest against the shanks of the forceps, but should constantly be held in a position just free from them. As the head descends the application handles move forward, and thus indicate the changing direction in which traction is to be made.

When the head has been brought down to the vulvar orifice the traction handle may be detached and the delivery completed as with the ordinary forceps; but the use of the traction rods, as a rule, may better be maintained throughout.

CHAPTER XXXII.

VERSION.

Version may be defined as a manual operation by which the long axis of the fœtal ovoid is wholly or partially inverted. Thus a cephalic may be substituted for a podalic presentation, or a podalic for a cephalic, or a transverse may be reduced to a longitudinal presentation. When the head is made to present, the operation is termed *cephalic* version; when the fœtus is so turned as to bring one or both feet into the birth-canal, it is called *podalic* version. The terms podalic and pelvic version are used interchangeably.

Version may be accomplished in one of three ways: by external, internal, or combined external and internal manipulation.

Indications for Cephalic Version. The indications for cephalic version are limited, since other than a head presentation is commonly due to some disproportion between the head and the pelvic inlet (Pinard).

Transverse and breech presentations when seen before labor or during the first stage prior to rupture of the membranes justify an attempt at cephalic version. To be successful, the membranes must not have been broken, and the pelvis must be sufficiently ample to receive and permit the engagement of the cephalic pole.

Indications for Podalic Versions in Transverse Presentations. In normal pelvis with the head presenting and the life of the mother or child threatened, if the head is not or can not be engaged, or the cervix is not sufficiently dilated to permit the use of forceps, podalic version is the operation of election. In certain cases of placenta prævia one or both feet may be brought down to control hemorrhage. In prolapse of the cord, when the membranes are ruptured and the head has not entered the brim, attempts at reposition having failed, version may be done. In prolapse of one or both arms, or of an arm and a foot, podalic version is indicated. In head presentations when owing to malposition or other complication the head fails to engage at the superior strait, as in face or brow presentation, twins or irreducible occipito-posterior positions or when proper flexion to secure engagement cannot be made; in anencephalus and in the minor degrees of hydrocephalus; in emergencies complicated with an unengaged head or an incompletely dilated cervix, as eclampsia, accidental hemorrhage, rupture of the uterus, embolism, and death of the mother, podalic version affords the most rapid means of delivery.

Podalic version is indicated in simple flattened pelvis when the conjugata vera is not less than 8 cm. (3.15 inches), the head being of typical normal size; and in all cases of equivalent disproportion between head and pelvis.

Contraindications to Podalic Version are: impaction or firm engagement

of the presenting part; tetanic contraction of the uterus with a well-developed ring of Bandl, appreciable two or more inches above the symphysis (Winckel); true conjugate below 8 cm. ($3\frac{1}{8}$ inches); oblique contraction in which the inlet is encroached upon; long-continued dry labor; cervix not dilated or dilatable. While the last two conditions do not positively prohibit the performance of version, the difficulties and dangers of the operation are so increased that the procedure is hardly justifiable.

Conditions Favorable to the Successful Performance of Version are: exact diagnosis; ample pelvic capacity, with approximate knowledge of the relative size of the child and pelvis; thin and flexible abdominal walls; and the presence of the whole or part of the amniotic fluid.

Dangers of Version. *To the Mother.* In external and bipolar version the dangers are insignificant. In internal version the woman is subject to the increased risks of possible uterine rupture, sepsis, hemorrhage, shock, and extensive lacerations of the cervix and pelvic floor.

The *Child* is exposed by the internal podalic method to injury or death from fractures of the humerus and femur, compression of the spine, and asphyxia during its passage through the birth-canal.

While under modern methods of diagnosis the field of version has been narrowed for the expert by traction forceps, symphysiotomy, and elective Cæsarean section, it will always remain a valuable procedure for the general practitioner in emergencies necessitating rapid delivery in the presence of an unengaged head, and when proper assistance and appliances for the performance of its alternatives are not at his immediate command.

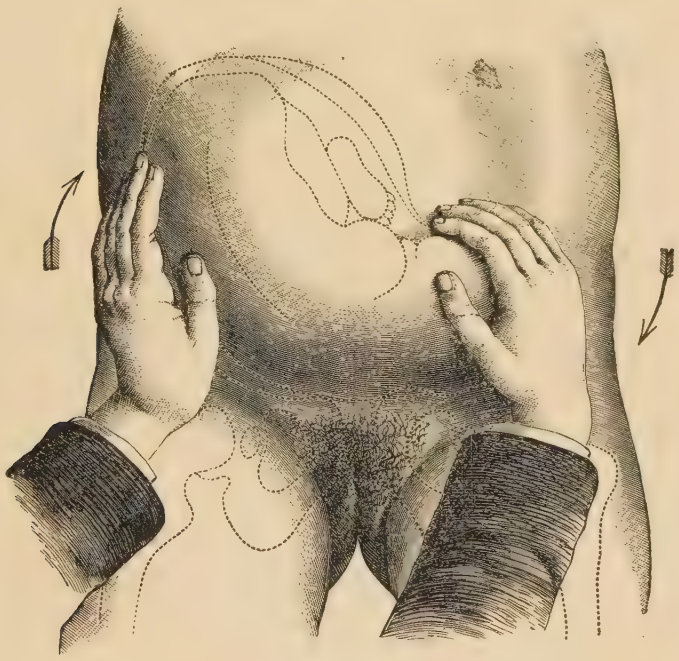
External Version. Version by external manipulation is employed to convert a breech into a head presentation or to correct transverse presentation. It is the simplest and safest method of turning, and is too seldom practiced, since few physicians become skilled in abdominal palpation. A positive diagnosis is essential before version is attempted by any method. Pelvic or podalic version by external manipulation is not always practicable. Cephalic version by the external method is frequently possible, and has been advocated in breech presentations by recent writers when seen before or at the beginning of labor. The presence of the liquor amnii, thin, lax abdominal walls, and an ample pelvis are prerequisites. The method is free from all danger of septic infection. Objections which have been urged against the conversion of breech presentations into head cases are: First. In primiparæ it is generally impossible without anæsthesia to perform fœtal evolution, because of the resistance of the maternal soft parts. Second. Fœtal accommodation will commonly cause the breech to return to the superior strait, owing to the continued existence of one of the four general causes of malpresentation and malposition, *i. e.*, small pelvis, large head, excessive liquor amnii, or small child. In multiparæ little is to be gained by the substitution of the head for the breech, as these cases usually terminate favorably, if properly managed, to both mother and child. On the other hand, substitution of the breech for the head by external version may be advantageous in oblique contraction of the pelvis when the antero-posterior diameter exceeds $3\frac{3}{4}$ (9.51 cm.) inches, since it enables the operator to direct the large occipital pole of the head toward

the most roomy side of the pelvis; in transverse presentations; in slightly flattened pelves; and in abnormal presentation of the placenta.

Contraindications to External Version. This operation cannot be effected when the presenting part has sunk deep in the pelvis, or when the amniotic fluid is scant or has already drained away, when the waters are excessive, or in the presence of a macerated fœtus or twin pregnancy. It is seldom practicable after the onset of labor.

Technique. *Preliminary Measures.* The position and size of the child are determined by abdominal palpation. The size of the pelvis is estimated. The bladder and the rectum are emptied. Irregular or spasmodic contractions of the uterus are controlled with an opium sup-

Fig. 448.



External version.

pository, if labor has already begun. The woman is placed in the dorsal position, with the head and shoulders elevated, the legs and thighs slightly flexed, and the knees apart. Anæsthesia is seldom necessary.

A hand is now placed on each pole of the fœtal ovoid, and by steady pressure the head is carried in the direction toward which the occiput points, while the breech is pushed toward the feet. This manipulation is checked from time to time by uterine contractions. Whatever gain has been made in the evolution must be held carefully until the uterus again relaxes, when the effort is continued until a favorable longitudinal presentation is obtained. When either the head or the breech is brought over the brim it should be made to engage, for until the presenting part has entered the superior strait the version is not complete.

This is usually accomplished when external version is made after labor has begun and regular uterine contractions are fully established, or by rupture of the membranes when the version is made during the latter part of the first stage. Under such conditions the head or breech may be crowded into the pelvis by suprapubic pressure with the patient in Walcher's position.

When the presenting part cannot be made to engage, the longitudinal relation of the fœtus must be retained by the application of pads and binder until labor is established, as the causes which had produced the primary malpresentation tend to reproduce it. In certain cases retention of the fœtus in the desired position can be maintained only by rupture of the membranes, an undesirable procedure because of the consequent dry labor.

Bipolar Version was perfected by Braxton-Hicks, who demonstrated the practicability of causing the relation of the long axis of the fœtal ovoid to conform with that of the uterus by combined external and internal manipulation. In Hicks's method the internal fingers do not pass beyond the presenting part.

The advantages of this method are: that it may be accomplished through a dilatation of the cervix that will admit but two fingers, during the first stage of labor, before the membranes have ruptured, or after rupture before the waters have drained away. Done under aseptic precautions there is less danger of infecting the uterus than in the internal method, as the fingers never penetrate the deeper parts of the womb. Shock, traumatism, and danger of injury to the fœtus are diminished. Separation of the placenta and prolapse of the cord are preventable accidents.

Indications for Bipolar Version.—Bipolar version is indicated in brow presentations when attempts at flexion and engagement have failed; in occipito-posterior positions of the vertex when postural and manual methods have not succeeded in bringing the head into the brim. In cross-births and in prolapse of the cord with but slight cervical dilatation, before the waters have escaped, bipolar version may be tried. In placenta prævia podalic version by this method brings the breech within the cervix much earlier than is possible by the internal method, securing compression of the placenta and arresting hemorrhage. In all of the foregoing conditions bipolar turning should be the operation of election.

Method of Performance. Strict asepsis is imperative. After the bladder and rectum have been emptied the patient is placed across the bed or upon a table, in the dorsal recumbent position, with the thighs flexed on the abdomen, the vulva, vagina, inner surfaces of the thighs, and the abdominal wall are rendered aseptic, and the hands of the operator covered with sterile rubber gloves. Anæsthesia facilitates the manipulation.

Before operating, the diagnosis should be confirmed under narcosis. Care must be taken not to rupture the membranes, as the presence of the the amniotic fluid favors easy evolution of the fœtus.

When *Cephalic version* is to be made by this method, Hick's clear and concise description will perhaps serve as the best guide: "Introduce the left hand into the vagina, as in podalic version, and place the right hand on the outside of the abdomen, in order to make out the

position of the fœtus and the direction of its head and feet. Should the shoulder present, push it with one or two fingers in the direction of the feet. At the same time pressure with the other hand should be exerted on the cephalic end of the child. This will bring the head down to the os; then let the head be received on the tips of the two inside fingers. The head will play like a ball between the two hands; it will be under their command, and can be placed in almost any part of the uterus at will; let the head then be placed over the os, taking care to rectify any tendency to face presentation. It is well, if the breech will not rise to the fundus readily, after the head is fairly in the os, to withdraw the hand from the vagina and with it press the breech from the exterior. The hand which is gently retaining the head from the outside should continue there for some little time, till

FIG. 449.

First step in bipolar podalic version. The hand is in the vagina, and the two fingers through the cervix displace the head, while the external hand carries the breech toward the side on which the feet lie.

the pains have insured the retention of the child in its new position and the adaptation of the uterine walls to its new form. Should the membranes be perfect, it is advisable to rupture them as soon as the head is at the os uteri; during and after the escape of the liquor amnii the head will move easily into its proper position." The procedure which has been quoted is so simple that there can be no objection to its trial, for if it fails podalic version may be done without removing the hand from the vagina.

Podalic version by this method finds more general application. The technique may be described as follows: One gloved hand is passed into the vagina, and two fingers through the cervix to displace the presenting part (the head), while the other hand is placed on the outside of the abdomen on the podalic pole. The choice of hand is of some importance. If the occiput is lying to the left, the use of the left hand has

an advantage; while if the occiput is to the right, the right hand will more easily displace it into the iliac fossa. With the external hand the breech is pushed toward the side on which the feet lie, while the internal hand tosses the head out of the excavation into the iliac fossa toward which the occiput points. As each successive part of the fœtus presents, it is tossed into the iliac fossa, while the external hand carries the breech into the lower uterine segment until a knee is brought within reach. The membranes are now ruptured and a foot brought down into the vagina. A podalic version is never complete until the breech is engaged.

It is well to make sufficient traction on the presenting leg to bring the knee to the vulva; when this has been accomplished it is evident

FIG. 450.

Second step in bipolar podalic version.

that the breech has entered the brim. When the evolution is complete the case may be left to terminate unaided as a pelvic presentation, unless need for rapid delivery exists.

Internal Version. In this method of turning the hand of the operator is passed into the uterus until a foot or both feet can be grasped and brought down through the cervix. This is the most effective and most commonly employed method of version.

INDICATIONS FOR INTERNAL VERSION. Many of the indications have already been mentioned under the general considerations for version. Chief among these are conditions of the mother or child calling for

prompt delivery, as eclampsia, placenta prævia, accidental hemorrhage, threatened or sudden maternal death, and prolapsus funis. In malpositions of the head, when attempts at flexion and engagement of the vertex have failed, internal podalic version may succeed when the conjugata vera is above 8 cm. (3.15 inches). The head may then be brought down through the superior strait by its smallest diameters. The head enters the brim as an inverted wedge.

Dangers and Contraindications. This operation should not be attempted before the cervix is fully dilated or dilatable or easily passable for the head without injury.

As the hand is passed deeply into the uterus, the woman is exposed to an increased liability to sepsis and to possible uterine rupture, owing to

Fig. 451.

Third step in (bipolar) podalic version.

the additional bulk of the uterine contents. Considerable shock is occasioned by the operation, and too precipitate delivery may be followed by lacerations and post-partum hemorrhage. This operation should never be done in a tetanic uterus with a high and well-developed retraction-ring, nor when the head is firmly impacted in the pelvis.

The Advantages are the speed and facility with which delivery may be accomplished, owing to the complete control which it affords of the fœtus and its evolution.

Method of Operating. Inasmuch as internal combined version has the broadest application and requires the introduction of the whole

hand and a part of the forearm into the uterus, it is necessary to impress the reader with the importance of observing the strictest aseptic technique. As internal version is most frequently performed after the membranes have ruptured and the uterus has closed down around the child, surgical anæsthesia will be useful by relaxing the uterus and contributing to the safety and success of the operation. This may be induced either by chloroform or ether, depending on the experience of the operator. Chloroform has, we believe, the advantage, as it relaxes the uterus sufficiently to allow the manipulations necessary to the evolution of the

FIG. 452.

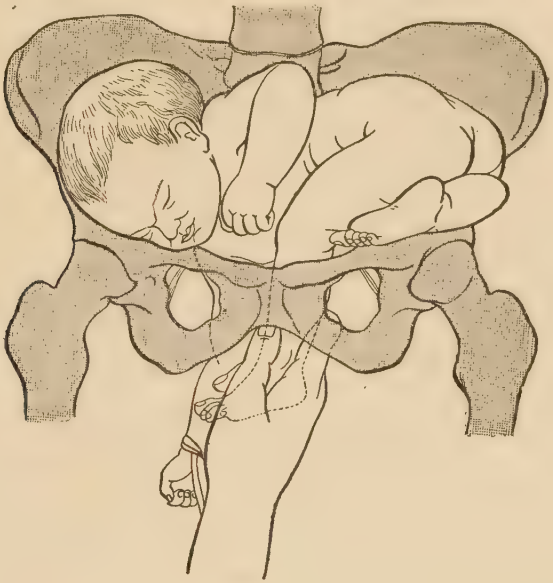
First step. Right dorso-posterior with prolapsed arm. A noose is placed on the presenting wrist to facilitate subsequent extraction. (FARABEUF and VARNIER.)

child, while its effect is so transient as not to produce secondary uterine relaxation and hemorrhage.

After emptying both bladder and rectum, the exact position of the fœtus must be mapped out carefully and the external genitals be made thoroughly sterile. The hair about the vulva is clipped with scissors and the pudendum scrubbed with soap and water while the patient is being anæstheized; the soap is then rinsed off with sterile water and the parts bathed with an antiseptic, preferably with a 1 or 2

per cent. solution of lysol, because of its lubricating properties. An ante-partum vaginal douche is unnecessary except in the presence of a purulent discharge from the vagina. The patient is placed across the bed or on a table in the dorsal recumbent posture, with the thighs flexed on the abdomen and the knees held apart by an assistant or maintained in position by the Robb or Bissell leg-holder or a Dickinson sheet sling. The vulvo-vaginal orifice is carefully dilated with the coned hand, the hand is then introduced into the vagina until the cervix is reached. If the cervix is not dilated or passable to the hand, its dilation is at once begun. This may be accomplished manually, as described by Harris; or should a constricting ring exist around the os which does not yield to

Fig 453.

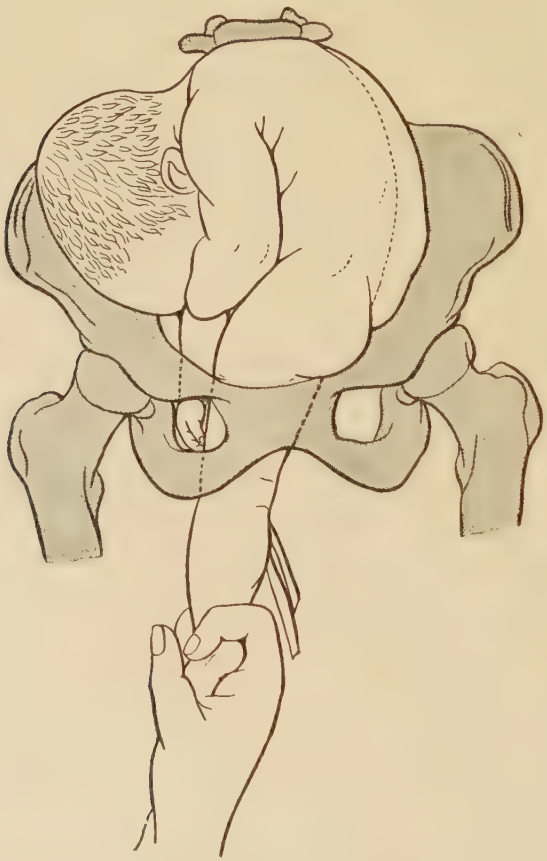


Second step. Grasping the upper foot. (Farabeuf and Varnier.)

the finger, it may be wise, where it is necessary to expedite delivery, to make six or eight nicks into the hardened ring of the cervix, distributed throughout its circumference. Multiple incisions made on these lines will facilitate dilatation and tend to prevent extensive laceration of the cervix. If the waters have not escaped, care must be taken to preserve the membranes during dilation. When the os is fully dilated, the hand is introduced through the cervix, and the membranes, if still intact, are ruptured. In longitudinal presentation advantage will be gained by using the hand, the palm of which will confront the child's abdomen. The hand is passed deeply into the uterus between the pains. If a contraction of the uterus takes place, the hand must be flattened out and held quiet until the pain has subsided. If the head is in the way, it is pushed to one side in the direction toward which the occiput points, and the hand passed along until a foot is grasped. Before

making traction on the foot the operator should make sure that the cord is not looped over the leg. If it is, it must first be disengaged. "As traction is made on the leg within the grasp of the hand the greatest possible aid may be derived from manipulating the head of the infant toward the fundus with the other hand externally placed on the surface" (Simpson). As the foot is drawn into the vagina and the knee presents

FIG. 454.



Third step. Grasping the foot and making traction. The arm ascends as the evolution is completed. (FARABEUF and VARNIER.)

at the vulva the head ascends into the fundus and the version is completed. Unless there is some indication for immediate delivery, all traction should cease and the patient be allowed to expel the child spontaneously until the umbilicus is born. This secures a greater dilation of the cervical canal and produces a paresis of the circular muscle of the cervix which facilitates extraction of the shoulders and the after-coming head.

In transverse presentation the method already described may be followed; but as the head is in one or the other iliac fossa the hand may be passed directly into the uterus and a foot sought at once. From that moment the operator is master of the situation.

In shoulder presentation where the arm has become prolapsed but has not become impacted, it may be replaced without difficulty and the version proceeded with; yet reposition of the arm is not necessary, for it will be drawn out of the vagina as the fœtus assumes a longitudinal presentation. An expedient which is found useful in the subsequent extraction which commonly follows podalic version is to fasten a loop of tape or a piece of roller bandage around the wrist before the arm is pushed up or drawn up by the evolution of the child; in this way at least one arm may be prevented from becoming extended during subsequent manipulation.

Impacted shoulder presentations afford the obstetrician ample opportunity for a display of his manual dexterity. In such cases the arm has become prolapsed and long-continued uterine contraction has caused the shoulder and thorax to become wedged into the pelvis. In the management of such a malpresentation the thorax must be carried up above the brim and displaced into the iliac fossa before attention is given to the prolapsed arm. This procedure is not only difficult, but dangerous as well, as uterine rupture is almost certain to result unless the greatest care is observed; a tetanic uterus with a more or less perfectly developed retraction-ring is an almost constant complication of impacted shoulder cases. This means that version, if made, must be done in the thinned-out lower segment of the womb.

To relieve such an impaction surgical anæsthesia is required.

If, after making well-directed pressure from below with the hand which corresponds to the prolapsed arm, while firm external counter-pressure steadies the fundus, the impaction cannot be relieved, embryotomy affords the best means of terminating the delivery. In another part of this chapter the relative value of version, craniotomy, and symphyseotomy will be considered in detail. Should it be possible to reduce the impaction of the shoulder and thorax, considerable difficulty may be experienced in completing the version, owing to the tetanic condition of the uterus which prevents the head from ascending to the fundus. Fœtal evolution may be expedited by the use of the following suggestion. For illustration, let us consider a left scapular anterior with a prolapsed arm and impacted thorax. Ether or chloroform narcosis will at least secure partial relaxation of the uterus. The right hand of the operator is now placed in the fœtal axilla just in front of the axillary line, and pressure is made from below upward and the shoulder and thorax pushed toward the mother's right iliac fossa. During this upward pressure the fundus must be held firmly by an assistant. As the shoulder is displaced enough room is gained to allow the hand to pass through the brim and into the uterus to seek a foot; the near foot should have the preference in this position. When the foot is grasped, it may be pulled into the vagina without causing the evolution of the child, as the tight uterus firmly holds the fœtus with its long axis transverse to that of the mother. If a loop of roller bandage is now slipped

over the foot in the vagina, traction may be made on it while the other hand of the operator is passed into the vagina alongside of the leg to push each successive fœtal part toward the fundus as it is forced down by the uterus into the brim; in this way the head rapidly ascends and a longitudinal presentation is secured. The force is practically applied to both poles of the fœtus at once; *i. e.*, upward pressure being applied with the left hand in the vagina, while traction is made at the same

FIG. 455.

Combined internal version. Applying force to both poles of the fœtus at once.

time on the leg through the use of the bandage traction noose with the right hand.

The Influence of Posture in Facilitating Version. The dorsal position with the hips elevated and well over the edge of the bed or table, the thighs flexed on the abdomen, and the knees widely separated, gives the operator the most direct and ready access to the fundus. During extraction, in bringing the after-coming head into the brim, additional space may be gained in the true conjugate by extending the thighs over the edge of the table (Walcher's position). This lowers the pubes and increases the antero-posterior diameter at the brim by 8.5 to 13 mm. The knees must be kept well separated, so as not to interfere with the extraction.

Version in dorso-posterior positions and in cases of pendulous abdomen may be facilitated by placing the patient on the side, in the latero-prone posture. She should turn on the side on which that pole of the fœtus lies which is to be brought down; *e. g.*, in a left scapulo-posterior the right latero-prone posture, and *vice versa* in left positions. When operating with the patient in this posture advantage is gained by slipping the hand beneath the child along the lateral aspect of the uterus. The right hand is employed when the patient is lying on her right side, and the left when she is lying on her left.

Either the knee-elbow or the Trendelenburg posture may be utilized with advantage when operating after the waters have drained away and the uterus holds the presenting part snugly against the inlet. In some impacted shoulder cases the Trendelenburg posture in conjunction with ether narcosis makes it possible to relieve an impaction in which repeated efforts with anæsthesia alone have failed. While theoretically the knee-breast position has many advantages over the ones referred to, it is difficult to use it in conjunction with anæsthesia; on the other hand, the Trendelenburg position has many of the advantages of the knee-breast, and, in addition, affords greater facility of narcosis. Mensinga has advocated the prone position during version. The superiority claimed for this posture is the same as may be had from the employment of any of those already described when the exact position of the child and the condition of the uterus have been fully determined.

The choice of hand in the performance of version is largely a matter of personal preference. Scientifically, it is dependent on the position of the fœtus and the posture in which the woman is lying. One will naturally use the hand which will pass most easily to the leg to be grasped; this presupposes accurate diagnosis. In cephalic presentation, when the patient is lying across the bed, the hand the palm of which will pass over the child's abdomen may be employed; while in transverse cases the hand which corresponds to the side on which the breech lies has the advantage. These rules apply also when the patient is in either the knee-breast or Trendelenburg posture. Many operators prefer to use the left hand for all versions, as the right hand is usually more dexterous in extraction.

The choice of foot is another question that has given rise to much discussion. In cephalic presentations there is little or no advantage in choosing one foot over the other, as traction upon either foot will rotate the dorsum to the front. In transverse cases it is wise to seize the knee or leg which will maintain a dorso-anterior position or will convert a dorso-posterior into a dorso-anterior; *i. e.*, take the further leg in dorso-posteriors, and the nearer leg when the fœtal dorsum is to the mother's abdominal wall (Hart). The observance of this rule will facilitate anterior rotation during the subsequent extraction.

According to Nagel, it is immaterial which foot is grasped so long as the leg which has been seized is brought forward behind the pubes, and as gradual traction is made between the pains the child's trunk is rotated toward the front.

When immediate and rapid delivery is to follow version the rule is to grasp both feet. This is to be particularly advocated in the presence of a premature, dead, or macerated fœtus, large child, or contracted

pelvis. How the leg shall be grasped is another practical consideration which merits description. With the hand toward the uterine wall, the foot may be seized between the index and middle fingers of the internal hand, so that the fingers are folded over the os calcis, the dorsum of the foot, with the ankle falling between them.

When seizing both feet the middle finger is passed between the child's ankles, and the other fingers are folded so as to surround both ankles.

Maintenance of the proper line of traction contributes to success in version. With the patient on a table traction in the axis of the inlet is possible, and the external hand may simultaneously operate through the abdominal wall to carry the opposite pole toward the fundus. Traction in the axis of the plane of the brim, or more properly in a downward and backward direction, is usually continued until the knee presents at the vulva, which indicates that the version is complete, when we pass from version to extraction.

The dangers to the mother from version, already mentioned in this chapter, are septic infection, shock, rupture of the uterus, and lacerations of the soft parts. In order to protect the woman from these accidents, an aseptic technique and timely operative intervention are requisite. The hands of the operator must be stripped of rings, the nails cut and cleaned dry, and the hands and forearms, including the elbow, thoroughly scrubbed with soap and water; ten minutes is not too much time for this detail. The hands and forearms are then rinsed in sterile or running water, and when possible, immersed in alcohol to free them from all fat and soap; finally, they are bathed in a solution of corrosive sublimate, creolin, formalin, or lysol; the latter possesses lubricating as well as strong antiseptic properties. For still further security the obstetrician should, if possible, wear rubber gloves with gauntlets.

Disinfection of the external genitals and immediate surroundings must be carried out after the bladder and rectum have been emptied. The hair should be clipped from about the vulva and the pudendum scrubbed with soap and water; the cleansing should include the abdomen and the inner surfaces of the thighs. After rinsing off the surplus lather with sterile water, all of the cleansed surfaces are washed with the antiseptic solution.

If the reaction of the vaginal secretion is acid, no preliminary douching is practiced; on the other hand, if the vaginal secretion is purulent, or is alkaline, or neutral in reaction, the passage is thoroughly cleansed with soap and water, followed by an antiseptic douche. If the membranes have ruptured and the waters drained away, or considerable time has been spent with the hand in the uterus, or the placenta has been removed manually, a post-partum intra-uterine douche may be given.

Shock may be guarded against by the timely use of strychnine, minute doses of morphine, and the introduction of a hot saline solution into the colon, or, where more prompt action is needed, directly into the cellular tissues, behind the mammary gland, or into a vein.

Version is especially dangerous when done after the amniotic fluid has drained away and a retraction-ring has developed. Under such conditions, the uterus is in a state of tetanic spasm, the greater part of the child being in the thinned-out, lower segment of the womb.

Neglected shoulder presentations constitute a most dangerous class of cases, and when a retraction-ring is appreciable between the pubes and umbilicus, with the patient anæsthetized, craniotomy or decapitation should be elected in lieu of version, to insure the best interests of the mother.

It is often possible to secure complete relaxation of the uterus under chloroform, and then with care and patience to succeed in bringing about the evolution of the child. The employment of the Trendelenburg posture adds greatly to the facility with which this may be done. Firm counterpressure must be made on the fundus to prevent the uterus being torn from its vaginal attachments during the upward pressure necessary to introduce the hand past the presenting part. After getting the hand in the uterus, if it is found that the child is dead, or that the lower segment is excessively thinned, or that the fœtus is hydrocephalic or a monster, version should not be made.

The injuries and lacerations to the soft parts following version and extraction consist of tears of the cervix, vagina, and pelvic floor; these are produced by rapid delivery through undilated passages. When circumstances permit, a spontaneous birth after version may prevent many of these injuries.

Prompt suturing of the perineal and vaginal tears protects the patient against sepsis. It is unwise to suture cervical lacerations unless hemorrhage is of sufficient moment to demand it.

Version and extraction through partially dilated passages expose the infant to the danger of asphyxiation. The operator must be prepared to combat this mishap, and have at hand means of resuscitation, which may be employed without delay. Two hæmostatic forceps will be found useful to clamp the cord; two small bath-tubs, one containing hot and the other cold water, ready for alternate immersion of the child, and a warm blanket to receive it, are among the ordinary requisites of the lying-in chamber. Many children may be saved by the prompt institution of one of the methods of artificial respiration. Either Schultze's method, or mouth-to-mouth insufflation, is to be given the preference. In using Schultze's method, expiration should be the first act, as in this way the respiratory passages are emptied of inspired mucus; it is also important to prevent chilling of the body by frequent immersion in warm water.

Shall Immediate Delivery Follow Version? As a rule, the two operations should be separated and spontaneous delivery encouraged. This must depend, however, upon the conditions in the particular case. If after cephalic version the head becomes flexed and engages, the labor may be left to itself or be terminated by forceps should the condition of either mother or child call for prompt extraction. On the other hand, if the head will not enter the brim as either a vertex or a face, podalic version is available.

To estimate the relative proportion between a flexed head and the pelvis in a given case, the patient should be in Walcher's position under an anæsthetic and the bladder and rectum empty. The sterile hand is then introduced into the vagina, and the head grasped and held in flexion, while the external hand attempts to crowd the flexed head into the pelvis. The axis-traction forceps will occasionally succeed in

bringing the head into the superior strait when other methods have failed. If the existence of positive disproportion has been demonstrated and the conjugata vera is not below 3.15 inches, podalic version and extraction of the after-coming head may be successful, as the diameters of the cranial vault diminish by compression as the head passes through the pelvis.

Extraction after podalic version may be immediate or deliberate, depending on the existing conditions in the particular case.

Accidental hemorrhage, placenta prævia, eclampsia, and prolapse of the cord in transverse presentations may demand rapid delivery; but the degree of dilation should largely govern the election of the rapid

FIG. 456.

Delivery of the first arm. Carrying the arm past the head.

or deliberate method. The writer is of the belief that one of the most fruitful causes of stillbirths is the habit of many practitioners to terminate labor immediately upon turning the fœtus, before complete canalization of the passages. Extraction under such conditions may be complicated by fractures of the femora and humeri, and by asphyxia of the infant. In one instance the writer saw the head severed from the body during an attempt at rapid delivery through incompletely dilated passages.

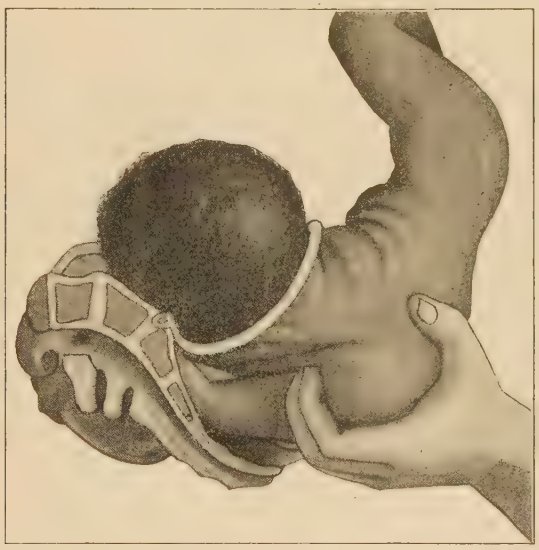
When version has been completed the operator should note the fœtal heart-rate and the general condition of the mother before determining the advisability of immediate or deliberate delivery. Wherever possible without compromising the interests of either, spontaneous delivery should be elected. The physician should be ready with sterilized hands and instruments to terminate labor at once in case of impending danger to either mother or child.

No discussion of version would be complete without briefly consider-

ing the methods of extraction which may accomplish rapid and safe delivery. While we have attempted to separate the two operations, each having its indications and limitations, the one follows the other with such frequency that many have come to assume that version includes extraction.

To perform rapid extraction the patient should be placed in the lithotomy position, either across the bed or on a suitable table. An anæsthetic is not always necessary; but if one has been employed during the version, it may be continued until the extraction is completed. When the foot emerges from the vulva, it is wrapped in a warm towel and grasped by the operator, and traction is made in a downward and back-

FIG. 457.



Delivery of the first posterior arm.

ward direction, in the axis of the brim, while an assistant makes well-directed pressure on the child's head to maintain flexion. This external pressure must be continued throughout the operation. As the buttocks emerge from the vulva, the index and middle fingers of the hand which corresponds to the flexed thigh are slipped into the groin and the hip lifted out; the pelvis is then grasped with both hands and traction continued, while the body is rotated into the oblique diameter of the pelvis, keeping the back well to the front. When the body is out it is carried upward over the pubes to disengage the flexed thigh and make it clear the vulva.

As the shoulders engage at the superior strait, the posterior shoulder strikes the pelvic floor first, and is shunted downward and inward until it is within easy reach. The rear arm, therefore, is the more easily liberated. If the assistant has succeeded in maintaining flexion by suprapubic pressure, the arm may be found flexed on the chest. It is common experience, however, that one or both arms slip up and become extended. To liberate the posterior arm, the feet are seized, and while

making traction the body is carried over to the side opposite the occiput. This causes the posterior shoulder to come into the median line within reach, the fingers of the free hand are passed along the dorsum to the shoulder and up the humerus to the elbow-bend, which is drawn downward, flexing the forearm across the face and chest of the child (Fig. 457).

To deliver the second arm, seize the trunk with both hands and push it up in the axis of the brim, to release the extended arm from the grasp of the pelvis, and at the same time rotate the body so as to bring the extended arm to the rear. This rotation may be assisted materially by grasping the delivered posterior shoulder and using it as a rotator. When the second arm has been brought to the sacral side the legs and trunk are carried to the opposite side, while the free hand sweeps the second arm and forearm across the chest (Fig. 458).

FIG. 458.

Delivery of the second arm, using the delivered arm as a rotator.

When the arms have been delivered there is usually little time to extract the head; this may be done either manually or instrumentally. The body is wrapped in a warm towel and laid upon the forearm of the operator, while the hand is passed into the vagina along the sacrum until two fingers can be hooked into the canine fossæ or the mouth, to maintain flexion and keep the long axis of the head in the oblique diameter of the pelvis. If the head has not engaged, suprapubic pressure with the closed hand may force the head into the brim. As the head reaches the pelvic floor traction is made by two fingers placed astride of the neck, and the body is carried upward and forward over the maternal pubes (Fig. 459).

In flattened pelves care must be taken to rotate the long axis of the child's head into the transverse diameter of the brim, and to have the patient in Walcher's position, in order to facilitate its engagement.

The management of the cord during extraction is of primary importance. When the breech has been delivered the cord should be pulled down and its pulsation noted; in case of short cord it should be secured

between two artery-clamps and cut. When it is possible, the cord should be placed in that part of the pelvis in which it will have the most room; this is generally in the space near the sacro-iliac joint opposite that oblique diameter in which the head descends; *i. e.*, if the head is coming through in the right oblique diameter, the cord will be in less danger of injury if it is placed opposite the left iliosacral joint.

Delivery of the after-coming head may be accomplished without difficulty, except in the presence of a large head or a contracted pelvis, if the steps of the mechanism are kept constantly in mind; *i. e.*, to engage the head, it must be flexed and rotated into one or the other of the oblique diameters at the brim. Rotation may be aided by

FIG. 459.

The Smellie-Veit method of extracting the after-coming head, augmented by suprapubic pressure.

manipulation through the abdominal wall with the external hand. The forceps should always be ready to terminate delivery in case of failure with manual methods.

Extensive lacerations of the pelvic floor may be avoided if version and extraction have been preceded by manual dilation of the vulvo-vaginal orifice, and if, after the mouth is delivered, time is taken to stretch the posterior segment of Hart by holding the head before letting the suboccipito-frontal and suboccipito-bregmatic diameters pass through the vulva. Notwithstanding the exercise of skill and care, rapid extraction of the fœtus at full term is rarely accomplished without extensive laceration of the maternal soft parts. These injuries, if the mother's condition is such as to warrant further procedure, should immediately be repaired. The presence of shock or the want of proper assistance and aseptic suture-material should postpone restoration; yet bleeding points that may give

troublesome hemorrhage are to be secured at once. Primary suture of tears in the cervix is of doubtful value in private practice; only when the rent is very deep or has severed the circular artery is suture positively indicated, to prevent the extension of infection to the parametrium or to control hemorrhage.

Internal version, followed by rapid extraction, exposes the woman to the possibility of partial or complete separation of the placenta, which complicates the delivery with more or less hemorrhage. Even when no separation of the placenta has taken place, immediate and rapid delivery increases the tendency to post-partum hemorrhage, since the uterus is not given time during the second stage for proper retraction and rearrangement of its fibres, such as take place when the expulsion is spontaneous. Upon delivery of the child, the uterus must be grasped through the

FIG. 460.

The Wiegand-Martin method of extracting the after-coming head.

abdominal wall and stimulated to contraction. If it does not promptly retract and all bleeding cease, manual expression of the after-birth will conserve the best interests of the mother. Every ounce of blood lost increases the shock.

When turning and extraction have been done for placenta prævia or accidental hemorrhage, an intra-uterine tamponade of iodoform gauze stimulates the uterus to contraction and maintains retraction, safe-guarding the patient against further loss of blood and, by securing a tight uterus, tends to fortify her against sepsis. The hypodermic use of strychnine over the womb in doses of $\frac{1}{15}$ grain, repeated every two hours for three doses, helps to combat tendency to relaxation. The effect of strychnine is superior to that of ergot, as it establishes a steadier and less spasmodic contraction of the uterine muscle.

The complications of version, made so much of by some writers, are chiefly encountered when the operation is badly chosen. When the diagnosis of position has been made, the indications and contraindications

thoroughly considered, and due care is exercised in its performance, rupture of the uterus and separation of the womb from its vaginal attachments will be less common sequelæ than a perusal of the literature would lead us to suppose. Unusual and complex presentations of the fœtus, such as a transverse with prolapsed arm and foot, or twins lying crosswise in the uterus, may seriously embarrass the operator; but with the proper appreciation of existing conditions, and by patient and persistent work under complete narcosis, these complications may be overcome and a longitudinal presentation be substituted.

The Influence of Ventro-fixation and Vagino-fixation upon Version. Should pregnancy follow either of these operations, the fixation may seriously complicate the labor. The posterior wall of the uterus is subjected to extreme dilation at the expense of its muscular strength, as the anterior wall, which is fixed by adhesions, does not participate in the uterine growth. Version in a uterus that is almost wholly developed from its posterior segment is fraught with danger of rupture. In such cases considerable difficulty has been experienced in getting the presenting part to engage when pregnancy has occurred.

When malpositions exist which necessitate turning, advantage will be gained if the operation is done early, by the bipolar method, before the membranes have ruptured. When the waters have drained away, version can most satisfactorily be made with the patient in the latero-prone posture.

The Relative Value of Version, Forceps, and Symphysiotomy. Forceps and version find their widest application in border-line contractions of the pelvis and in malpositions of the head when the pelvis is ample. The field of symphysiotomy begins where that of forceps and version ends; *i. e.*, with a conjugate of less than $3\frac{1}{2}$ inches.

In flat pelves of moderate contraction version has an advantage over forceps, as the long occipito-mental diameter of the fœtal head can be brought into the transverse of the inlet and the occiput guided through the roomiest part of the brim. On the other hand, in slight general contraction forceps used in conjunction with the Walcher posture offers the best prognosis for mother and child.

The comparatively recent researches of Milne Murray show that all the engaging diameters of the cranial vault are reduced by an occipito-frontal seizure with the forceps; thus the supposed advantage of version, the overlapping and under-riding of the cranial bones, is controverted by practical experience. The dexterity and practice of the operator must also be taken into consideration in determining the relative value of forceps and version. The expert with the axis-traction forceps may be able to bring a head through the superior strait that one less skilled might sacrifice. However, the general rule for emergencies still holds good—*i. e.*, that where rapid delivery is demanded and the head has not engaged at the pelvic inlet, version is the operation of choice, while forceps is to be chosen when the head is in the brim.

Version has been successfully done in conjunction with symphysiotomy, but the liability to produce extensive lacerations of the soft parts forbids its general use. Pinard's method is based on better surgical principles. He puts each case to the practical test of tentative traction with the forceps, with the patient in Walcher's position; if the head cannot be made to engage, pubic section is made while the forceps is in position.

CHAPTER XXXIII.

EMBRYOTOMY.

Embryotomy is a term applied to destructive operations on the fœtus by which the size of the head or trunk, or both, is sufficiently diminished to permit their passage through the birth-canal. It is a generic term which includes all operations designed to facilitate delivery by perforation, crushing, or segmentation of the fœtus.

Perforation, cranioclasis, cephalotripsy, and basiotripsy are the mutilating operations performed upon the head. Those on the body include cleïdotomy, amputation of extremities, spondylotomy, decapitation, and evisceration.

In the present state of obstetric surgery embryotomy has but a limited field. Since in the majority of cases the head presents, craniotomy has the widest range of application.

CRANIOTOMY.

Indications for Craniotomy. Craniotomy is indicated in: (1) Disproportion between the size of the fœtal head and the pelvis, if the child is dead, when the conjugata vera is not below $2\frac{1}{2}$ inches; (2) In pelvic deformity, in which the conjugata vera exceeds $2\frac{1}{2}$ inches (6.34 cm.), and forceps, version, or Cæsarean section is either impossible or too dangerous to the mother; (3) In the presence of tumors complicating labor by narrowing the birth-canal, as malignant disease of the cervix and bony growths in the pelvis, when Cæsarean section cannot be elected; (4) Perforation and cranioclasis may be done in certain cases of lateral placenta prævia in which the child is surely dead or non-viable; (5) In dystocia due to hydrocephalus not manageable by aspiration through the bregma in the forecoming head, or by tapping through the spinal canal when the head comes last; (6) In impacted posterior face presentation and in occipito-posterior cases, when their reduction is impossible or the election of symphysiotomy would be unfavorable to the mother; (7) In brow presentations after the membranes have ruptured, the amniotic fluid has drained away, and a well-marked retraction-ring is formed.

Is Craniotomy Ever Justifiable on the Living Child? Stoltz, Pinard, and Veit have declared that it is never necessary to have recourse to destructive measures on the living child, and some writers go so far as to say that "any man who, in the light of recent researches, deliberately sacrifices an unborn child, simply confesses his ignorance of the progress of obstetrics." There can be no question that during the past decade, Cæsarean section, induction of premature labor, and the reintroduction of symphysiotomy have narrowed the field of destructive operations. But do the results of conservative operations show that the mother has as good a chance by Cæsarean section as by craniotomy? It

must be admitted that in hospital practice, with every facility for aseptic operative work, and where a diagnosis of pelvic deformity can be accurately made before labor, or when the labor is not too far advanced in the second stage, Cæsarean section has a very low mortality.

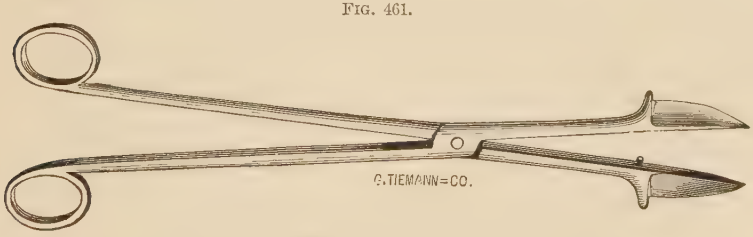
In private practice craniotomy, which saves the mother, is preferable to symphyseotomy or Cæsarean section, which gives considerable mortality. The interests of the mother must always take precedence over those of the unborn child.

In country practice, where the aid and counsel of a skilled associate cannot be had, mutilation may be considered, after a full explanation of the relative merits and dangers of the life-saving operations has been made to the patient or her family. The author fully believes that the untrained physician with incompetent assistance should not elect symphyseotomy or Cæsarean section, as two lives instead of one are almost sure to be sacrificed by unskilful operation.

Craniotomy is to be preferred to all other operations when the child is in danger, and the mother is ill and exhausted or threatened with uterine rupture. It has been suggested that the physician might delay operation until the child is known to be dead, and then craniotomize. This is dishonest and a violation of duty, for not only is the life of the child sacrificed, but the mother is exposed to the dangers of post-operative shock, sepsis, and uterine rupture following upon a tedious labor. There is really no reason that pelvic deformity sufficient to necessitate embryotomy or Cæsarean section should not be recognized before labor begins, if routine ante-partum mensuration is practised, except in cases seen with other physicians in consultation. If repeated and unsuccessful applications of the forceps have been made, the patient is already septic, and any major operation will increase her risks.

Prognosis of Embryotomy. It must be remembered that embryotomy in a highly contracted pelvis is not without risk to the mother, because of the extensive lacerations of the cervix, vagina, and bladder that may be made in bringing a fœtus piecemeal through so limited a space. The bruising and laceration of the soft parts lower the resistance of

FIG. 461.



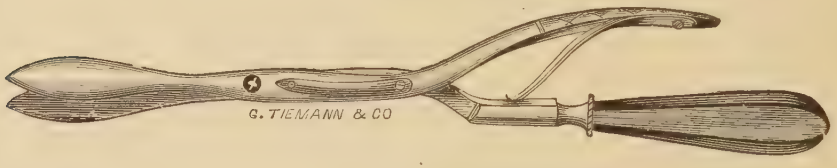
Smellie's scissors.

the tissues and predispose the patient to active septic infection. The success or failure of embryotomy depends upon the particular case; *e.g.*, the condition of the mother at the time of operation, the size and the shape of the pelvis through which the work has to be done, and the method of extraction after perforation has been made. The result is most favorable when that method of extraction is used which will do the least injury to the soft parts of the mother.

In estimating the prognosis of embryotomy the following must

be taken into account: The degree of pelvic contraction, the size of the child, the manual skill of the operator, the physical condition of the patient, and the amount of bruising and laceration which she

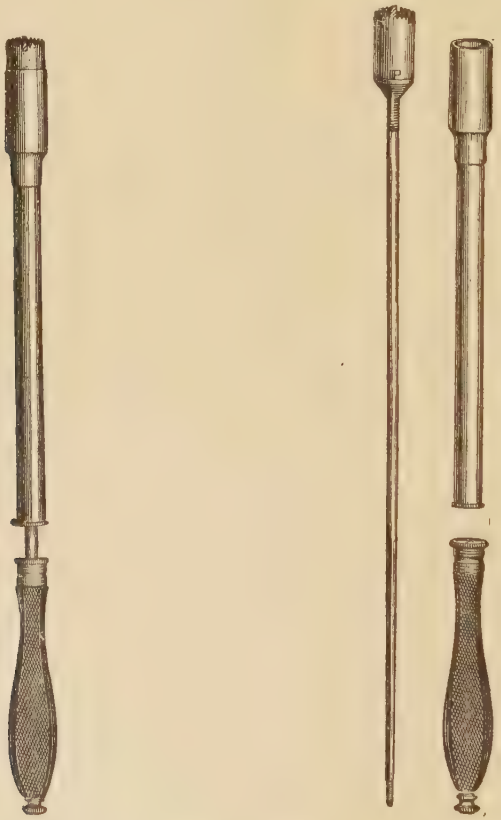
FIG. 462.



Blot's perforator.

has sustained before the operation is begun. Previous unsuccessful attempts at delivery with forceps and version tend to increase the mortality when embryotomy is performed.

FIG. 463.



Martin's trephine.

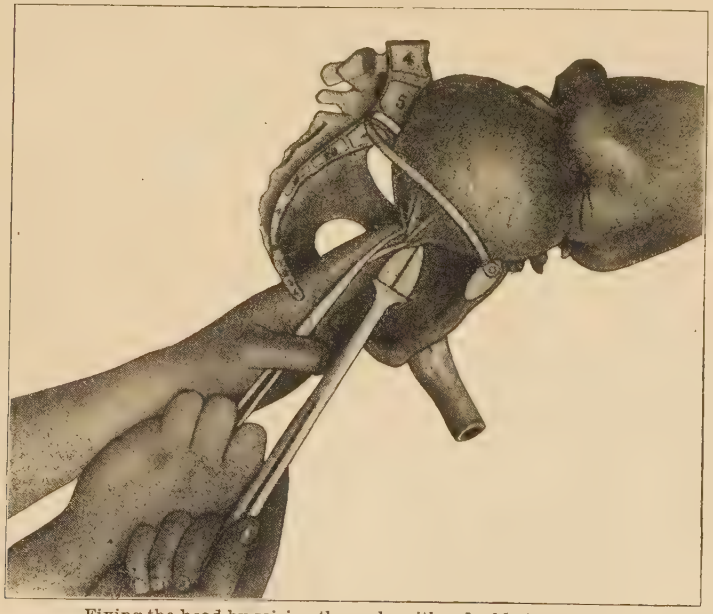
Technique of Craniotomy. Mutilation of the head is accomplished by perforation and comminution. The perforation may be made with scissors, a perforator, or a trephine (Figs. 461–463). Comminution

of the cranial vault with short craniotomy forceps has given place to the employment of the cephalotribe and basiotribe, which are used to compress, crush, and extract. The cranioclast is a tractor. Decapitation is performed with the blunt hook or écraseur. An ordinary pair of strong scissors and a stout, straight forceps are all that is needed for evisceration.

After thorough sterilization of the operators' hands, instruments, and passages, the bladder and rectum having previously been emptied, the patient is placed on a table and anæsthetized. When the narcosis is complete she is brought to the edge of the table in the lithotomy position, and the flexed thighs held by two assistants or retained in position with a sheet-sling or leg-holders.

If the head is impacted in the cavity of the pelvis, perforation will be easy; on the other hand, if the head is unengaged, it must be held firmly against the brim by a competent assistant while the perforation is being made. In the absence of proper assistance the skull may be fixed by seizing the scalp with a strong double tenaculum and the cranial opening made, even without anæsthesia (Fig. 464).

FIG. 464.

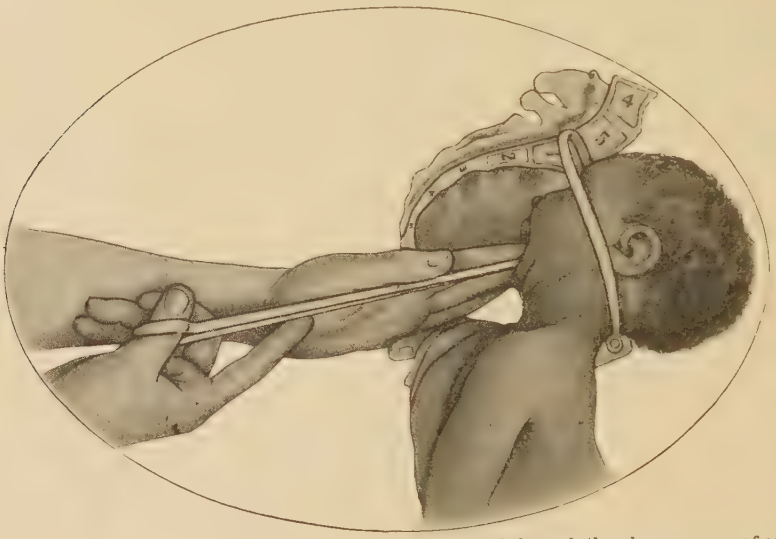


Fixing the head by seizing the scalp with a double tenaculum.

To perforate, the half hand, covered by a sterile glove, is introduced into the vagina and the presentation, position, and posture reascertained. If the disproportion between the head and the pelvis is not too great, the head may be opened though a fontanelle or suture; but if the disproportion be considerable, a permanent opening would better be made through one of the parietal bones. With the fingers in the vagina against the presenting part, to act as a guide, a perforator or trephine is introduced, guarded by the fingers, and plunged into the skull. The greatest care

should be taken to keep the instrument at a right angle to the surface of the skull, as otherwise the instrument may slip between the scalp and the cranial bones without entering the head. If a suture is not accessible, as is commonly the case in flattened pelves, the hole may be made through the presenting parietal bone. The point of perforation should be nearer the symphysis than the promontory (Fig. 465).

FIG. 465.



Perforation of the after-coming head. The scissors are passed through the pharynx or roof of the mouth.

When the perforating scissors have been passed in under steady pressure to the shoulder-guard, the blades are spread apart to enlarge the opening; then closed and turned at a right angle to the original incision, when the blades are again separated. In this way a crucial incision is secured. When this has been done, the scissors are pushed into the cranial cavity and moved about until the brain is thoroughly broken up; special effort is made to reach and to destroy the medulla. The scissors are now withdrawn and the finger or fingers slipped into the opening to act as a guide through the remaining steps of the operation. A hard-rubber or metal nozzle attached to a Davidson syringe is introduced into the cranium alongside of the finger and the broken-up cerebral matter washed out. Having thus diminished the size of the head, its delivery is in order; this may be accomplished by nature or by traction with the finger hooked into the cranial opening, the forceps, or the cranioclast. Many cases of minor dystocia will be delivered spontaneously after perforation, and only where there is indication for haste, because of the condition of the mother, should extraction immediately follow perforation (Zangemeister).

It must be remembered that extraction by any of these methods (finger, forceps, or cranioclast) is possible only in slight disproportion between the head and pelvis, as the reduction in the size of the head is accomplished by the pressure of the walls of the pelvis. When the skull is too hard

or too large to come through in this way it must be reduced by comminution or compression.

Perforation may be done without an anæsthetic and done early when evidence of fœtal death is positive, while extraction always requires narcosis.

Spiegelberg advises that extraction should always follow perforation because: 1. The expelling powers are often inefficient. 2. Prolongation of the operation is always disadvantageous because of sepsis and exhaustion. 3. The opening may close by overlapping. 4. Extraction is not dangerous when done early.

At what point of the fœtal skull should we perforate? In vertex presentations, when a trephine is available, the opening should be made through the presenting parietal bone near the pubes. When the perforation is made with a scissors perforator, a suture or fontanelle is selected as

FIG. 466.

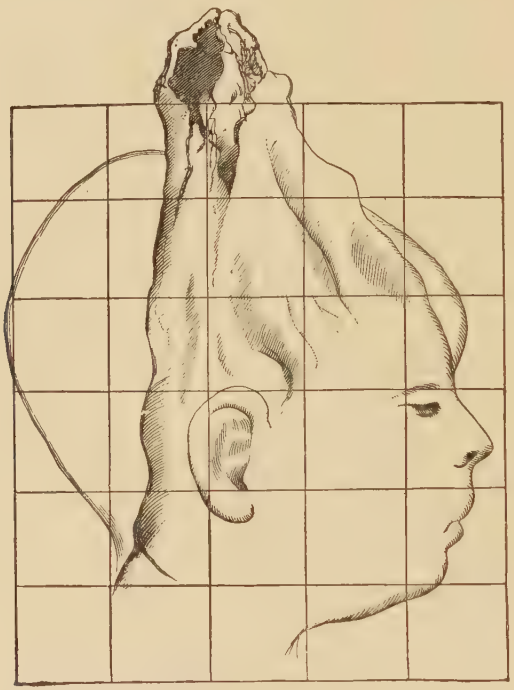
Entering the skull through the occipital bone subcutaneously.

the site of puncture. In face presentations the perforator may be passed through an orbit or one of the frontal bones, or through the roof of the mouth behind the nasal fossa. The guiding fingers must not be withdrawn from the vagina until the cranioclast or basiotribe has been applied.

After perforation of the skull its size may be reduced by comminution with the craniotomy forceps, if a cephalotribe is not at hand. The cranial bones are seized with forceps, which is passed beneath the scalp; the instrument is rotated in its long axis until the bone is detached and can be withdrawn. The maternal soft parts are protected by the scalp during the torsion, and by the fingers within the vagina during the extraction of the bone. The bones are removed one by one until the size of the head permits its extraction. It may be necessary in the higher grades of pelvic contraction to crush the cranial base as well as the vault. The basiotribe is used for this purpose.

Cranioclasis. One blade of the cranioclast is introduced through the opening in the cranium, which has been kept patulous by the guiding fingers, while the other blade is applied to the external surface of the head. The instrument is then firmly locked and the compression screw in the handle turned home. With the firm grip thus secured traction

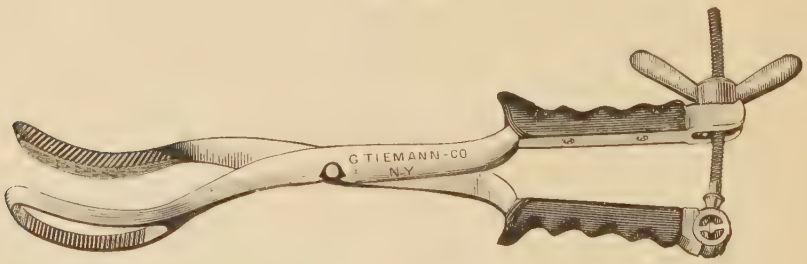
FIG. 467.



The head after delivery by the cranioclast.

may be made downward and backward in the axis of the pelvic brim until the head is brought to the pelvic floor, when the traction is continued in an upward and forward direction, as in ordinary forceps

FIG. 468.



Braun's cranioclast.

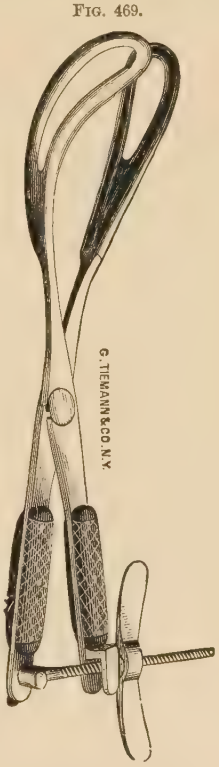
delivery. Cranioclasis after careful comminution with the craniotomy forceps is applicable even in high degrees of pelvic contraction.

CEPHALOTRIPSY.

The purpose of this operation is to crush the skull in order to permit its passage through the birth-canal, when extraction cannot be accomplished by the cranioclast. The cephalotribe (Fig. 469) is a powerful compressing forceps with a strong compression screw at the end of the handle. It is applied to the sides of the head as is the ordinary forceps. Perforation is, of course, the initial step, as in craniotomy. The advantage claimed for the cephalotribe is that it enables the operator to overcome the difficulties presented by a fully ossified head, in that it can be used as a crusher as well as a tractor. On the other hand, it has the disadvantage that, since it is a bulkier instrument than the cranioclast, and since both blades are applied outside of the skull, it occupies more room in the pelvis, and that while diminishing the diameter of the head in one direction it increases it in another.

This operation is applicable only in the minor degrees of pelvic contraction. It is a more dangerous procedure than cranioclasis, owing to spicula of bone which are likely to project as a result of the forcible crushing, and also because of the increased room needed for its application, both of which causes will subject the maternal parts to greater traumatism. After the compression screw has been sufficiently tightened, keeping in mind that the crushed cranium is elongated in the diameter opposed to that in which the crushing force is applied, traction is made in the axis of the brim, adjusting by rotation the long diameters of the crushed head to the long diameters of the cavity and outlet. After perforation, cranioclasis, cephalotripsy, or basiotripsy an antiseptic intra-uterine douche or one of sterile water completes the operative technique.

FIG. 469.



Lusk's cephalotribe.

Occasionally, cranioclasis may not succeed in crushing the portion of the occipital bone which forms the base of the cranium. If it is necessary to reduce the size of the base, the occipital bone must be crushed. The Tarnier basiotribe was devised to attain this end. This instrument is at once a perforator, cranioclast, and cephalotribe. Its chief advantage is that it may be used in a pelvis of such contraction that neither cephalotribe nor cranioclast can be employed; even in a pelvis having a true conjugate of $1\frac{3}{4}$ inches (4.44 cm.) its application is possible. Embryotomy through a brim of so high contraction should be condemned on general principles; $2\frac{1}{2}$ inches should be accepted as the limit for any embryotomy; the damage to the maternal soft parts, even with such a conjugate, will be considerable.

The basiotribe is composed of a perforator, two blades of unequal length, and a powerful compression screw attached to the handles (Figs. 470, 471). When closed and the compression screw is turned home the

blades measure from side to side $1\frac{1}{2}$ inches, and from before backward $1\frac{3}{4}$ inches. Its application is as follows: The perforator is bored through the cranial vault and into the base of the skull; when this is driven

FIG. 470.

Tarnier's basiotribe.

FIG. 471.

Basiotripsy accomplished.

home the blades are applied to each side of the skull, locked, and the compression screw tightened until the base is thoroughly crushed. Extraction is then completed as when the cranioclast or cephalotribe is used.

Decapitation.

Decapitation, or the removal of the head from the body, is an operation which is fortunately rare in modern midwifery, because of a more accurate diagnosis and earlier interference on the part of the physician than formerly in transverse presentations of the fœtus.

The indication for performing such mutilation is a neglected transverse presentation which has become impacted, fœtus dead, and a retraction-ring so well defined that rupture of the uterus is imminent and version positively contraindicated.

Fœtal monstrosity may render delivery impossible except by decapi-

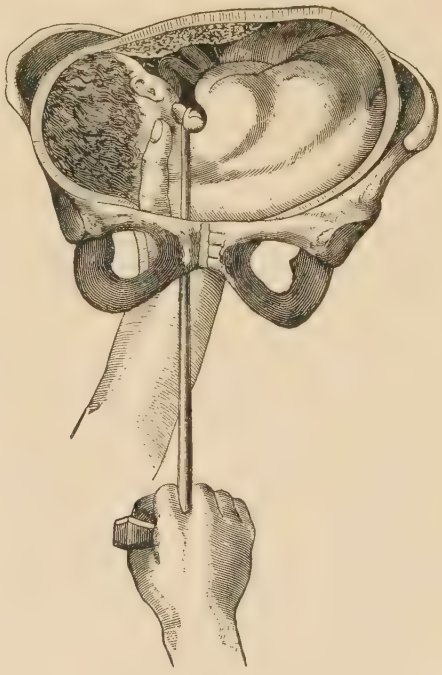
tation or evisceration. In transverse cases which justify such procedures the position of the neck will determine which is the more feasible. Where the neck is accessible and a hook can be passed over it, decapitation is the operation of choice; on the other hand, when the neck of the fœtus cannot be reached evisceration is the operation of election.

Braun's decapitating hook, or *decollator*, is the most efficient instrument yet devised to divide the vertebral column. This consists of a steel rod fitted with a strong transverse handle at one end and a short blunt hook at the other. The hook forms an acute angle with the shaft of the instrument (Fig. 472). The hook is passed over the neck of the child and pulled down until the neck rides well up into the apex of the

FIG. 472.

Carl Braun's decapitation hook.

FIG. 473.



Decapitation by the hook.

angle. Then by a steady pendulum motion, accompanied with traction on the handle, the neck is severed.

A strong cord or a chain-saw may be utilized to behead the fœtus when a decapitating hook is not at hand, if the neck is sufficiently accessible to permit of its passage above it, or the passage of a well-lubricated elastic catheter, to which the cord or saw may be attached and carried into place. This procedure is always attended with considerable difficulty, owing to the skill and patience which are required to pass either catheter, cord, or saw about the neck. A knot or a loop at the end of the cord facilitates the manipulation. When the cord has

been put in place the two ends are to be brought out of the vagina and a tubular speculum passed over the ends and into the vaginal orifice, to protect the tissues while the neck is sawed through.

To insure the safety of the mother during decapitation a most scrupulously aseptic technique is imperative. These patients are often already septic and lacerated to a greater or less degree, and further traumatism to the maternal soft parts must carefully be guarded against. After the bladder has been emptied, the hands of the operator, instruments, and the field of operation are rendered aseptic, and the patient anæsthetized and placed in the lithotomy position. A fœtal arm, if accessible, is brought out of the vagina and given to an assistant to make traction on, in a downward and backward direction. This steadies the neck and brings it within reach. A noose of tape looped about this arm facilitates the subsequent manipulations, by permitting downward and backward tractiom to be made on it, without the assistant being in the way of the operator. The operator inserts his half or whole hand into the vagina. The right hand is chosen if the head is to the mother's left, and the left when the head is to the mother's right. Two fingers are now passed along the pubic or sacral wall of the pelvis and into the uterus, until they can hook over the neck. If the dorsum is to the mother's front, the fingers may be passed along the pubic side; if to the mother's back, advantage will be gained by carrying the hand along the sacrum.

The hook is now run in flat, along the fingers, and guided around the neck from above downward. When in place firm traction is made upon it, while the hook is rocked back and forth until the neck yields. The fingers must be kept in position to guard the maternal structures from injury.

After the head is severed from the trunk the body may be delivered by traction on the prolapsed arm and the head slips upward as the trunk glides by. The head may be extracted by seizing the inferior maxilla with the fingers to maintain flexion and control rotation while suprapubic pressure is made with the other hand, or by forceps if the pelvis be sufficiently ample to permit cephalic engagement. If, on the other hand, the pelvis is so contracted as to make engagement by the suboccipito-mental, suboccipito-frontal, and bitemporal diameters impossible, the head may be steadied against the brim, perforated, and extracted by cranioclasty or basiotripsy.

Decollation in Locked Twins. Decapitation may be necessary to relieve the impaction in case of twin presentation with locked chins. The child partly born with the breech presenting is usually dead; if it is not, the chance of life is so small that it may be sacrificed in the interest of the other twin. A strong, blunt-pointed curved scissors may be utilized to sever the neck in this location; to prevent the scissors from slipping up and doing damage to the maternal structures, a piece of stout rubber tubing may be tied about the neck, and the vertebral section made below this guard.

Evisceration and reduction in the size of the trunk are elected in certain cases of transverse presentation of the fœtus, in which the neck is inaccessible to the hook, in breech births, when the fœtus is too large to pass through the pelvis, or when because of monstrosity or pathological

enlargement of the fœtal structures delivery without mutilation is impossible.

The abdomen or the thorax may be opened with blunt-pointed scissors and the viscera removed with the fingers or forceps. The ribs are divided to diminish the size of the chest, and the clavicles severed (cleidotomy) in their middle third to reduce the transverse measurement of the shoulders. Extraction is made with the blunt hook or cranioclast.

When the back of the fœtus presents, making decapitation and evisceration as ordinarily performed impossible, the trunk may be steadied with a strong volsella and the spinal column divided with scissors; with the trunk thus opened from the back, it may be seized and drawn down by the cranioclast until the body can be snipped through with scissors. The two halves may now readily be reduced and delivered. Should the arms embarrass extraction, they may be amputated.

During decapitation and evisceration the mother is subjected to the danger of sepsis and laceration of the soft parts. The first is guarded against by strict attention to aseptic detail, and an antiseptic intra-uterine douche should follow delivery, when necessary for the removal of loose shreds of tissue which otherwise might be retained. Immediate suture should be made of all accessible maternal lacerations.

Arrest of the after-coming head at the brim or within the cavity of the pelvis may demand craniotomy; under such circumstances the child is usually dead and the indication is clear. Of the various procedures recommended for these cases, the method described by Strassmann is especially safe, thorough, and practical: "The head is fixed by introducing the index and middle fingers into the open mouth and making traction upon the lower jaw. The breech of the child is carried up over the pubes toward the mother's abdomen, and a scissors perforator is then passed through the pharynx to the base of the skull, and through the foramen magnum, dividing the bones between the occipital condyles." A metal catheter is introduced through this opening and the brain carefully broken up and washed out. Perforation through the mouth is usually safe.

To complete the delivery, the head is flexed by making traction on the lower jaw with the index and middle fingers, which are introduced into the mouth, while suprapubic pressure is applied with the other hand. Should manual extraction fail, labor may be terminated by the forceps or cranioclast.

Hydrocephalus of an after-coming head, causing dystocia, may necessitate craniotomy, since the position of the head is so high in the pelvis that the mouth is not readily reached. Successful perforation may be made through a skin incision at the base of the neck posteriorly; the perforator being passed under the skin, is made to enter the occipital bone, and extraction is accomplished by the cranioclast.

In minor degrees of hydrocephalus puncture of the spinal canal to allow for the escape of cerebrospinal fluid may reduce the cranial diameters sufficiently to permit their passage through the pelvis. This procedure and aspiration through a fontanelle in the forecoming head do not necessarily cause the death of the child.

Craniotomy in connection with symphysiotomy has been suggested and been performed as an emergency procedure; but such an operative combination cannot be considered as advisable in the light of modern obstetrics.

Embryotomy is generally inadmissible in pelves below $2\frac{1}{2}$ (6.34 cm.) inches, while $2\frac{3}{4}$ (6.97 cm.) inches is the lower limit for symphyseotomy. *Basiotripsy* followed by evisceration would do less damage to the maternal structures than the above-mentioned combination. The occasion for embryotomy with pubic section could arise only from poor judgment or from a failure to recognize pelvic contraction by previous examination during pregnancy or at the time of labor. So high a degree of contraction as to necessitate these operations should be apparent to the most casual observer. Again, many of these patients are already septic from repeated examinations and ineffectual attempts with forceps, and version before symphysiotomy is considered, which fact of itself would contraindicate pubic section.

Prognosis for Embryotomy. In skilful hands and in properly selected cases, embryotomy is a comparatively safe operation. The time at which the operation is done, the size of the pelvis, and the condition of the maternal soft parts influence the prognosis. The maternal mortality and morbidity from embryotomy are higher in private than in hospital practice. This is accounted for by the lack of accurate estimation of the relative size of the fœtus and pelvis, which is unfortunately too common in private work, and by the fact that embryotomy is made an operation of last resort, after ineffectual attempts at delivery with forceps, in an exhausted, septic, and lacerated woman.

Choice of Procedure. In the higher degrees of pelvic contraction, such as call for basiotripsy, the destructive operation is attended with a greater mortality than in Cæsarean section, even when the pelvic space is sufficiently ample for embryotomy, if there is reason to believe the uterus is infected, the chances for the mother may sometimes be better with the Cæsarean operation followed by hysterectomy than with piecemeal extraction of the child. If the womb is already septic and the woman's strength is good, Cæsaro-hysterectomy may be elected, with the possibility of improving the prognosis.

In rupture of the uterus, if the rent is incomplete or if the fœtus has not escaped into the abdominal cavity, craniotomy may properly be elected. After the child has been extracted the tear may be tamponed with iodoform gauze. When the child or the greater part of the ovum has escaped from the uterus, embryotomy must give place to abdominal section.

In concluding, the author believes that the choice should be between Cæsarean section and embryotomy in high degrees of pelvic contraction; and as accurate, early diagnosis, pelvimetry, and fetometry become more common, the already narrow field of the sacrificial operation will become still more limited.

CHAPTER XXXIV.

CÆSAREAN SECTION. PORRO OPERATION. SYMPHYSIOTOMY.

CÆSAREAN SECTION.

Cæsarean section is an operation for the delivery of the child at term by means of an incision through the abdominal and uterine walls.

It is commonly assumed that Cæsarean section takes its name from Cæsar, who is said to have come into the world in this way. Pliny, however, derives the term from the Latin *cædere*, "to cut," and mentions several other celebrities of ancient times, among them Scipio Africanus and Manlius, as being among the number of "*Cæsones*" as they were called.

The practice of Cæsarean section belongs to prehistoric times. A Romon law, ascribed to Numa Pompilius, the "*lex cæsarea*," forbade the burial of a pregnant woman before the fœtus had been taken away from her, and this was generally done through an abdominal incision.

It having been once shown that many children were saved in this way after the death of the mother, the question arose whether it would not often be right in cases of protracted labor, in which the life of the child was threatened, to perform the Cæsarean section upon the living mother. The proposal, however, met with bitter opposition. It was urged that to open the abdomen of the mother, even when her condition is hopeless, in order to save the child, is a criminal procedure, and Virchow cites an instance in which a physician was prosecuted for performing Cæsarean section on a dying woman with the hope of saving the child.

The first authenticated Cæsarean section on the living woman was performed in 1610 by Trautman of Wittenberg, Germany. There is reason to believe that the earlier recorded operations upon the living were not true Cæsarean sections, but laparatomies for abdominal pregnancy.

A great deal of discussion has been directed to the treatment of the uterine wound. In former times the wound was left unsutured. Sänger, in 1882, did great service by the introduction of a secure uterine suture.

Indications. The indications for Cæsarean section may be (1) absolute or (2) relative.

Cæsarean section on the living woman should be undertaken in cases in which there is no prospect that the fœtus, even after embryotomy, can be extracted by the natural passages with less danger to the mother. In pelves measuring 6.5 cm. (about 2½ inches) in the conjugate diameter, with a living child, or 5 cm. (2 inches), with a dead child, Cæsarean section is necessary to save the mother's life. Here the indication is absolute because no other less dangerous alternative presents itself. It is said to be relative when the operation is elected in preference to other possible methods of delivery.

Even in pelves with a conjugate diameter of 6.5 to 7 cm. elective Cæsarean section is a better operation than its alternatives. Its mortality in elective operations should not exceed 5 per cent. for the mothers and the same for the children. While the maternal mortality of induced labor is practically nil, the infant death-rate from prematurity is not less than 33 per cent. The best results of symphysiotomy are about the same as those of Cæsarean section for the mothers, but the infant mortality is greater; moreover symphysiotomy is not suited to pelves with a true conjugate below 7 or 7.5 cm. Embryotomy is not entirely without a maternal death-rate and the children are all sacrificed.

With a conjugate diameter of more than 7 cm. choice may be made between Cæsarean section, induced labor, symphysiotomy, and craniotomy. The prognosis for induced labor in slight contraction is better than in the class of pelves last considered, since the viability of the child is greater. When the time for induced labor has passed, the choice of operation lies between Cæsarean section and symphysiotomy. When the mother is exhausted by long labor and repeated attempts at delivery or is otherwise in bad condition for abdominal section, symphysiotomy may offer a better prospect than Cæsarean section. Yet if there is reason to believe that the uterus is septic and the mother is not too much exhausted and the child is viable, Cæsaro-hysterectomy should be performed. If the child is dead, or non-viable, or a monster, embryotomy should be performed in the interest of the mother.

We believe with Williams, of Baltimore, that the upper limit for the absolute indication for Cæsarean section should be advanced to 7 cm., and the relative indication to 8.5 cm. for flat and 9 cm. for generally contracted pelves. Williams holds that Cæsarean section should be performed in preference to symphysiotomy in minor degres of contraction in which forceps or version is inadequate. He would, therefore, when the relative indication is present, allow the labor to go on for one hour in the second stage, and would then elect Cæsarean section in preference to high forceps on the movable head, or to version if the head fails to sink into the pelvis after moulding.

It should be remembered that the capacity of the pelvic cavity and of the outlet as well as the inlet must be taken into account in electing the method of delivery.

An examination should always be insisted upon before the beginning of the ninth month of pregnancy, to decide whether relative disproportion exists. If the measurements of head and pelvis are determined in good time, it will usually be possible to select the method of procedure and be prepared to meet existing emergencies.

In moderate degrees of pelvic contraction, on the border line between the field of forceps and that of the incisive operations, it is impossible in the advance of labor to determine definitely the prognosis for delivery by the natural passages. In this class of cases much will depend on the size and plasticity of the fœtal head and the strength of the pains. As a rule the dimensions of the head may be learned with sufficient accuracy by measurement through the abdominal wall just before term. The efficiency of the pains and the possibilities for moulding of the fœtal head cannot be known till tried. When, therefore, the pelvic space is such that the indication for Cæsarean section is not clearly assured before labor

the major operation should be deferred till the second stage of labor as Whitridge Williams has advised. After about one hour of expulsive pains it will usually be possible to decide with certainty the necessity for the incisive operation.

Should the head fail to engage, Cæsarean section is indicated if the condition of mother and child permits. Often in cases primarily in doubt the head engages after moulding and delivery occurs spontaneously or may safely be completed with axis-traction forceps. So long as the question of procedure is in doubt no attempt at delivery by forceps or version should be made. Extreme precautions, too, should be observed against infection of the birth canal.

Even though the bony pelvis be ample, obstruction may be present in the soft parts. A uterine or ovarian tumor in the lesser pelvis, which cannot be dislodged, may afford the indication for Cæsarean section. In cancer of the cervix frequently the rigidity of the cervical tissues is such as to preclude delivery by the natural passages. Here Cæsarean section should be followed by total extirpation of the uterus and appendages if the disease has not progressed too far.

The Cæsarean operation has been proposed and practiced in certain cases of eclampsia and placenta prævia, but with rare exceptions the latter complications of labor are better managed by the ordinary obstetric procedure.

The preferred time for operation is just before the end of pregnancy. By the history and symptoms and by accurate measurements combined with palpation it is possible to decide approximately when the fœtus is mature. It is not necessary to wait until labor-pains come on to ensure contraction of the uterus after delivery; neither is it necessary to wait for marked dilation of the cervix to ensure drainage from the uterine cavity afterward. Sometimes, for obvious reasons, the surgeon may be compelled to operate during labor.

Preparation. In addition to the usual dressings and accessories the instruments needed for the operation are:

1. Scalpels;
2. One dozen artery forceps;
3. One pair of scissors;
4. A large thin-walled rubber tube as a uterine ligature;
5. Needles threaded, with carriers;
6. Needle-holder.

A careful chemical and microscopical examination of the urine should have been made previously on more than one occasion. The patient should, if possible, have been kept under observation for some time. The bowels should have been carefully regulated, and both rectum and bladder emptied immediately before operation.

On the evening preceding the operation the abdomen and pubes should be shaved and prepared aseptically as for an ordinary cœliotomy. A compress of bichloride (1 : 1000) is applied and kept on until the patient is brought to the operating-table.

The Operation. After being anæsthetized, the patient should be placed on the table with the buttocks resting upon the perineal pad. The healthy vagina in the gravid woman needs no disinfection. If diseased, it should be cleansed thoroughly by scrubbing with soft soap on a ball of

absorbent cotton held in stout forceps, every fold being exposed. It may afterward be irrigated with a 10 per cent. solution of creolin. About a drachm of iodoform and boric acid powder (1 : 7) may then be thrown up into the vault of the vagina, the cavity being afterward filled with a pack of iodoform gauze. In health all interference within the vagina should be omitted. The toilet of the abdomen is completed in the usual manner.

The operator may by external examination definitely determine the presentation and position of the child if this has not already been done. Just before the final cleansing of the abdomen the strength and frequency of the fœtal pulse should be noted.

The upper abdomen, the chest, the thighs, and the flanks are covered with sterilized towels; a large piece of gauze of four thicknesses covers the whole body from the chest to the knees, a slit being cut in it from the navel to the symphysis. If the head is wedged in the pelvis, the towels and gauze which cover the upper part of the thighs should be so arranged that an assistant may exercise upward pressure with the hand through the vagina during the extraction of the child. Operator, assistants, and nurses directly concerned in the operation should wear sterile rubber gloves.

The operation is often done in from twenty to twenty-five minutes; sometimes it takes three-quarters of an hour.

The length of the abdominal incision must be greater when the uterus is to be brought out of the wound before opening it than when it is incised *in situ*. With the former method the uterus can be kept under better control, and it is easier to prevent the entrance of fluids into the abdominal cavity, but against this must be put the greater length of incision, which presents the following disadvantages: (1) An extensive scar, with consequent weakening of the abdominal walls, often followed by hernia; (2) the greater extent of adhesions occurring later between the uterus and the abdominal wall, which are likely to be in proportion to the size of the cicatrix. Upon this point Zweifel lays great stress. Yet should the uterus be septic it must be eventrated before opening it to lessen the risk of peritoneal infection.

With the second method an incision of 15 cm. (6 inches) will usually be sufficient, and this shorter incision is generally to be preferred. The description which follows will deal, therefore, more especially with Cæsarean section in which the uterus is incised and evacuated *in situ*.

The abdominal incision extends about one-third its length above the umbilicus and two-thirds below. Skin and fascia are cut through and the muscles separated by blunt dissection. An assistant with a pair of forceps now catches and raises a small portion of the peritoneum and the operator, with a second pair, takes hold of another portion at a point a short distance from the first. A nick is then made between the two forceps, and the operator, introducing the finger into the opening and using it as a guide, cuts through the remainder of the peritoneum. The uterus is now brought into view, and an elastic ligature is passed over the fundus and placed around the lower segment. The two ends are held by an assistant, who exercises light traction, compressing the uterus and fixing it against the symphysis. The latter procedure serves two purposes: it keeps the uterus steady and at the same time prevents excessive hemorrhage.

The location of the placenta may be determined usually before incision of the uterus. When the round ligaments are far apart, converging downward, the placenta is upon the anterior wall. When the reverse is the case the placental insertion is upon the posterior wall.

If the placenta lies in the way it is the usual practice to detach the edge and push it to one side. Time is saved and no more bleeding is occasioned by cutting rapidly through it. When the placenta does not underlie the incision, the membranes will be seen pouting through the incision and presenting a blackish appearance.

The assistant, with his hands upon the abdominal wall, steadies the uterus, holding it centrally. The uterus is incised from the fundus to a point just short of the retraction-ring with care not to cut the membranes. The incision is carried boldly through the whole thickness of the uterine wall, notwithstanding the bleeding, which may be quite free. The operator, passing his hand through the membranes into the uterine cavity near the fundus, grasps the nearest fœtal extremity and, drawing it out, rapidly extracts the child.

A leg may be seized if it can readily be found or the child may be delivered by the breech. As a rule the extraction of the child is easily and speedily effected by grasping the head with both hands. Usually the uterus now contracts and bleeding is, in the main, controlled.

Fritsch recommends a transverse uterine incision at the fundus and Jewett has operated by this method in several cases. Müller opens the uterus at the fundus, but longitudinally instead of transversely. The chief advantage of the fundal incision is greater security in closing the wound. It insures the avoidance of the lower non-contractile portion of the uterus, in which it is difficult to close the wound securely. The median longitudinal incision beginning at the fundus and falling short of the ring of Bandl is almost universally preferred.

While an assistant holds the child in a large piece of sterilized gauze, the operator applies two clamps to the umbilical cord and cuts between them. The child is then handed over to an assistant and the stump of the cord is ligated at leisure.

When this has been done, the hand, inserted into the uterus, grasps the fœtal surface of the placenta. The fingers are then closed upon it, squeezing it like a sponge. In this way it is freed from its uterine attachment and gradually withdrawn, the membranes peeling off from the uterine wall.

The uterine wall has thus far been protected by the amniotic membranes from risk of infection. If left untouched, it remains aseptic. No douching and no dusting with antiseptic powders is required. As a rule the hemorrhage will be slight, but should it be excessive the flow may be controlled temporarily by an assistant, who should grasp the uterus below the body or tighten the ligature around the lower segment.

The objection to tightening the rubber ligature primarily lies in the fact that tight and prolonged constriction may paralyze the nerves and favor uterine relaxation and subsequent hemorrhage. The uterus may be stimulated to contract by the application of hot towels and, if need be, by faradism. The same object is promoted by the subcutaneous injection of $\frac{1}{2}$ drachm of the fluid extract of ergot immediately before

the abdominal incision is closed. Usually the first uterine sutures provoke contractions and help to check oozing.

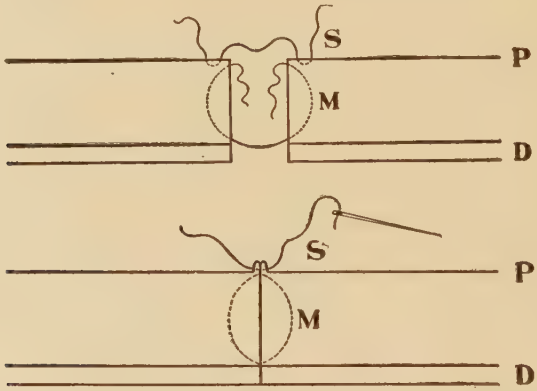
The contracted uterus may now be lifted out of the abdominal cavity and laid upon a large piece of sterilized gauze, which also serves to prevent protrusion of the intestines, or the uterus may better be sutured *in situ*, without removal from the abdomen. The latter method lessens chilling and consequent shock.

The uterine incision is closed with a row of deep interrupted sutures of No. 2 chromated catgut, three to the inch. These are made to engage a considerable extent of the muscularis on each side and they fall short of both the mucous and the serous coats.

Each suture is tied firmly enough to bring the surfaces snugly together and stop hemorrhage from the wound as well as from the needle punctures. Slight blanching of the surrounding tissues at the point of entrance and exit will show when the sutures are tight enough.

The deep sutures are completely covered in with a continuous peritoneal suture of thin catgut running the entire length of the wound. Each

FIG. 474.



Diagrams to show the placing of sutures in the uterine wound after Cæsarean section. P. Peritoneum. M. Musculature. D. Decidual layer. S. Superficial or peritoneal suture.

loop is made to enter and emerge on the peritoneal surface just outside the incision, and should include just enough underlying tissue to secure a firm hold. The suture is then carried across the incision and made to engage a similar fold of peritoneum on the opposite side. The peritoneum is thus drawn over the deep sutures, forming a welt which covers the wound in the uterus. This method of suturing the serosa is analogous to the intestinal sutures devised by Czerny and Lembert.

Since the opposed serous surfaces become agglutinated within a few hours the peritoneal suture seals the wound against leakage of lochia into the peritoneum. It is especially useful when the labor has been prolonged and forceps or other manipulations have been employed, whereby the patient has become much exhausted. After all the sutures have been introduced, if everything has gone right, the wound surface should remain dry.

The peritoneal surfaces are cleansed of blood and liquor amnii by gently pressing them with a dry cheese-cloth sponge.

Particular attention should be paid to the renal fossæ, a fresh sponge on a holder being carefully carried up into each. The surface of the intestines and of the pelvic cavity behind and in front of the uterus and broad ligaments should also be sponged clean. The uterus, if it has been lifted out, is now replaced within the abdomen.

If the omentum is brought down in front of the uterus it may become adherent to the uterine suture line and the stomach and transverse colon be dragged down as involution progresses. For this reason some operators prefer to dispose the omentum behind the uterus before closing the abdomen.

The abdominal wound is closed by a continuous fine catgut suture for the peritoneum, interrupted sutures of chromic catgut or silver wire to bring together the fascia and a subcuticular suture, or ½-inch strips of sterile adhesive plaster for the skin.

The catgut sutures may be reinforced by four tension sutures of silkworm gut. Each is made to engage ¼ inch of the fascia on each side; its ends are then crossed and carried through fat and skin well out upon the surface of the abdominal wall. The two ends of each pair on either side of the incision are tied together over a bolster of cheese-cloth or through a short section of rubber tubing. The tension sutures may be placed before closing the fascia and tied after closing the skin.

The abdominal dressing is applied and held in place by a suitable bandage.

The urine is drawn, after which the vulva is covered with a loose pad of absorbent cotton; this is changed every three or six hours.

After-treatment. It may be necessary to give one or two hypodermic injections of morphine (⅛ to ¼ gr.) to insure the patient a good rest on the first night. After the first twenty-four hours there will be but little pain, and the hypodermic injections under ordinary circumstances must not be continued. After twenty-four hours the child should be put to the breast and from this time the nursing may be regulated as in ordinary obstetric practice.

The bowels are opened on the third day.

The bladder is evacuated within eight hours and after each urination the parts are cleansed by irrigating with boric acid solution. Catheterization should be avoided if possible.

The subcuticular suture, if non-absorbable, may be removed on the tenth day. After two weeks the patient may be allowed to remain for a short time each day in a reclining-chair. During the third week she may sit for a part of the day, and during the fourth begin to walk. An abdominal bandage may be worn for several weeks or months.

It is important to determine the position and size of the uterus two or three months after the operation, and to ascertain whether fixation to the abdominal wall exists.

In addition to the foregoing, the following points in the technique of the operation are worthy of mention:

1. In private practice the operation is most frequently performed at the patient's home, and since to-day we ought to preserve almost equally well our aseptic technique in a private house as in a hospital, care should be taken that all necessary preparations are made beforehand and not left till the operation has begun. In this way the different

steps may follow one another with the utmost rapidity consistent with accuracy and attention to detail.

2. If the uterus has probably been infected before operation the conservative Cæsarean section is not sufficient, the organ must be removed. Drainage should be provided by way of the vagina.

THE PORRO OPERATION.

Porro preferred to supplement the ordinary Cæsarean section by amputating the uterus in its lower segment, the tubes and ovaries being also removed. The advantages claimed for this operation, which is more mutilating than the one just described, are as follows:

1. There is no risk of hemorrhage from the uterine incision either during or after the operation;

2. The woman will never again be put in the same dangerous situation.

Indications.

The Porro-Cæsarean section is indicated, therefore:

(1) When the labor has been prolonged, the membranes have been ruptured for some time, and manipulations have been undertaken involving the uterus which make the occurrence of sepsis very probable.

(2) In the presence of active gonorrhœal infection.

(3) When the uterus or appendages are diseased to such an extent that a subsequent operation will certainly be necessary for their removal.

(4) In pelvic contraction or obstruction in the soft parts, rendering the delivery of a subsequent child impossible, it is justifiable, with the consent of the patient and her relatives, to prevent the recurrence of pregnancy, which has already proved so dangerous, by Porro's operation or by removal of the Fallopian tubes close to the uterus.

(5) Failure of uterine contractions after Cæsarean section may necessitate hysterectomy.

The **technique** of the operation is, in the first steps, the same as in the one just described. After the extraction of the child the uterus is eventrated, and the ligature around the lower segment of the uterus is tied tightly to control the circulation. The uterus is cut rapidly away at a point $2\frac{1}{2}$ or 3 cm. above the ligature, and the tubes and ovaries are also removed. The operation is completed by ligating the ovarian vessels and each of the uterine vessels in the stump. The part of the uterine cavity above the rubber ligature is disinfected with pure carbolic acid, applied by means of absorbent cotton on an applicator.

In the original Porro operation the abdominal wound is closed down to the stump, the peritoneum around the lower angle of the wound being attached by a running suture on all sides to the pedicle, thus completely shutting off the peritoneal cavity.

The stump is kept from retracting into the abdominal cavity and slipping out of the knot by forcing two sterilized knitting-needles through the rubber ligature and the stump. These needles rest upon pads which protect the surface of the abdomen.

This method of procedure has been superseded by the subperitoneal method of hysterectomy as commonly practised in supravaginal amputation of the non-gravid uterus. For a detailed account of the procedure, text-books on gynecology may be consulted.

Vesical disturbances do not arise generally in these cases, there being abundant room in which the bladder can expand.

VAGINAL CÆSAREAN SECTION.

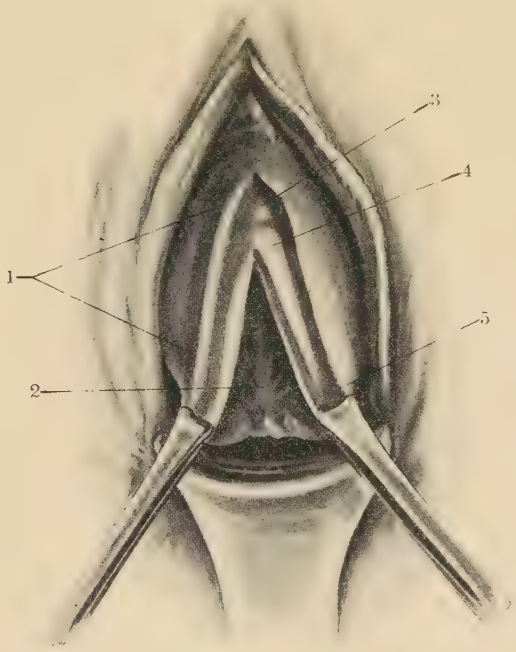
This operation was first proposed by Dührssen in 1895. Very rarely in certain emergencies it may replace the abdominal operation. The indications suggested by Dührssen are the following:

1. Abnormal conditions of the cervix and lower uterine segment impeding delivery, such as carcinoma, myoma, rigidity, stenosis, etc.

2. Conditions requiring prompt delivery, especially grave eclampsia. Here may be included certain cases of placenta prævia, of accidental hemorrhage, of prolapsus funis, and of threatened rupture of the uterus.

3. Impending death of the mother.

FIG. 475.



Vaginal Cæsarean section. (BUMM.)

The operation is contraindicated in pelvic contraction sufficient to forbid delivery by forceps or version.

The author of the operation had performed it in 22 cases within the first five years after its proposal. Bumm operated in 52 cases with a mortality of 23 per cent. Veit reports 33 cases in which the operation was performed in eclampsia with one death from pneumonia.

Dührsen's latest technique is very similar to that of anterior colpocœliotomy as sometimes practiced in gynecologic surgery.

Ergot may be given hypodermically shortly before operation. When

necessary in primiparæ, ample room may be obtained from a right lateral vagino-perineal incision. The field is fully exposed by means of short broad retractors.

The cervix is held well forward with traction forceps, one caught in each lateral aspect, or with silk tractors. The anterior vaginal wall is incised transversely at the level of reflection as in vaginal hysterectomy. The bladder is separated from the uterus mainly by blunt dissection. When required the anterior vaginal wall may be separated from the bladder and divided by a median longitudinal incision, 1 inch or more in length. The bladder is now held forward with a long retractor passed beneath the pubic arch and the anterior wall of the uterus is split in the median line from the lower border of the cervix to a point above the os internum, a distance of about 6 cm. The amniotic sac falls into the opening. The opening, if necessary, may be dilated manually. A posterior cervical incision is usually required. The membranes are ruptured and the child extracted by forceps or version.

The placenta is removed by the hand or by the usual external manipulation and the uterus tamponed.

The edges of the uterine incision are caught with traction forceps near the angle, held down and brought together with sutures. The sutures are tied on the anterior surface of the uterus. If the posterior wall has been incised it is closed with sutures tied on the mucous surface. The vaginal incisions are sutured, a small drain of gauze or rubber tissue being left between the cervix and the bladder. This is removed in twenty-four hours. The perineal incision is closed with catgut or silk-worm gut.

In malignant or myomatous disease of the uterus, instead of suturing, the usual technique of vaginal hysterectomy is carried out.

SYMPHYSIOTOMY.

Symphysiotomy (from *σύμφυσις*, a joint, and *τομή*, a cutting) is an operation for the artificial division of the pubic symphysis during labor, for the purpose of increasing the diameters of a narrowed pelvis, and thus permitting the birth of a living child through the genital canal.

History. The operation was performed on a dead woman in place of a post-mortem Cæsarean section, for the purpose of saving a living child, by Jean Claude de la Courvée, at Warsaw. The date is variously given as 1644 and 1585.

Although the credit of proposing the operation on the living woman, with the intention of delivering a viable child, belongs to René Sigault, who, while yet a student in Paris, advocated the procedure in 1768 before the French Academy, an Italian surgeon, Domenico Ferrara, who had been in Paris, and who was acquainted with Sigault's views, was the first to carry out the suggestion. Ferrara operated in Naples in 1774. The woman died. Sigault himself performed his first symphysiotomy in 1777 at Paris. He operated six times and lost 1 mother and 5 children.

Morisani, of Naples, in 1866, working in the same hospital in which Ferrara had performed his first symphysiotomy, carried out the procedure successfully; mother and child both survived. From this time the operation began to be more generally employed, though up to 1890 the

majority of all symphysiotomies had been done at Naples by Morisani and his pupils.

In 1891 Spinelli, a pupil of Morisani, went to Paris to lay the results obtained at Naples before the French profession. His successes and those of Morisani made a favorable impression upon Pinard, who became an earnest advocate of the operation, and performed 19 symphysiotomies in something over a year, saving 19 women and 16 children.

The first reported case in America was performed by Jewett, who operated on September 30, 1892. Barton Hirst, of Philadelphia, did the operation a few days after Jewett.

Symphysiotomy was introduced, in the main, as an alternative for Cæsarean section. The maternal mortality in the latter, as originally practiced for over eighty years, had been approximately 100 per cent., and it can hardly be wondered at that any procedure which promised better results should be hailed as a Godsend. Yet to-day, owing to the almost uniformly good results of Cæsarean section and its greater scope, symphysiotomy is seldom performed.

Morisani in 55 cases lost 3.5 per cent. of mothers and 5.5 per cent. of children. Zweifel, of Leipsic, in 31 cases lost 4 children and no mothers.

Bar in 22 cases saved all the mothers and all the children. Küstner in 7 symphysiotomies had no maternal or fœtal deaths. In 8 cases operated upon by Jewett, 7 of the mothers made good recoveries and 1 died of œdema of the lungs a few hours after operation. All the children but one were delivered alive, though not all of them survived the first month.

Indications for the Operation. The field of symphysiotomy has in recent years become a very limited one. This is due in part to defects inherent in the operation and to the steadily improving status of Cæsarean section.

Symphysiotomy does not effect delivery, but merely prepares the way for it. The anatomical limitations of the operation are very narrow and exact measurements of the pelvis—and especially of the child's head *in utero*—are impossible. The proper selection of cases for pubic section is attended with difficulty and symphysiotomy in a pelvis too small is a grave mistake for mother and child. Cæsarean section, on the other hand, ensures immediate delivery in all cases irrespective of the degree of contraction.

Symphysiotomy, however, may be performed in cases in which the operator can be assured that only a little more pelvic space is required for delivery. It affords a means of saving both patients in conditions in which the judicious use of forceps has unexpectedly failed. Forceps, indeed, should always be tried before resort to pubic section.

It may be chosen, too, in certain cases of pelvic contraction within the limits already mentioned when the mother is too much exhausted to permit abdominal section. Here the prognosis of symphysiotomy is good for both patients, while the mortality of the Cæsarean operation is formidable when performed after long labor or repeated attempts at delivery by forceps or version.

Field of Symphysiotomy in Pelvic Contraction. The operation may be performed: (1) In simple flat pelves with a conjugata vera between 7.5

and 9 cm. (3 and 3½ inches). (2) In generally contracted pelves with a conjugata vera between 9 and 10 cm. (3½ and 4 inches). These rules presuppose that the head of the child is of normal size.

Briefly, the operation occupies a field just beyond the scope of forceps. Its chief rival in cases of the same degree of pelvic narrowing may be said to be embryotomy. In any but slight degrees of pelvic contraction, if at all, it cannot take the place of Cæsarean section. Symphysiotomy or the Cæsarean operation should replace perforation of the living child almost wholly.

Symphysiotomy is contraindicated in ankylosis of one or both sacro-iliac joints and by infection of the uterus. In the latter condition Cæsarean section followed with hysterectomy offers the best chance for the mother.

Rationale of the Operation. As has been said, the operation depends for its success upon the lengthening of the conjugate and the general enlargement of the area of the superior strait. When the pubic symphysis, together with the subpubic ligament, is divided and the pubic bones are separated from each other, they move not only outward from the median line, but also downward in a direction toward the feet. This is due to the fact that the axis of rotation at the sacro-iliac joints is not parallel to the long axis of the body, but runs from without inward and from above downward.

This peculiarity of rotation has been well explained by Wehle, who compares the separation of the pelvic halves very aptly to the opening of a pair of double doors. Should the doorposts be vertical and the axis of rotation vertical, the under surface of the doors, when opened, will describe a plane perpendicular to the axis of rotation and tangential to the earth's surface, the lower outer angle of the door neither descending from nor approaching the floor; but should the doorposts be set at an angle from above downward and inward toward each other, then the doors, when opened, will still describe a plane perpendicular to the axis of rotation, but directed in each case from within outward and downward. The downward movement of the pubic bones, with the accompanying nutation of the sacrum, of itself increases the length of the conjugata vera.

A separation of 3 cm. (1.1 inch) causes a descent of 2 cm. (0.7 inch), and the fœtal head pressing upon the ends of the separated bones drives them still further downward. Another important thing to keep in mind is the fact that the anterior prominent part of the child's head, which in the majority of cases is one or other of the parietal prominences, is received in the space between the sundered bones. We see, then, that the canal for the passage of the child is rendered larger in three ways: (1) By separation of the ends of the bones, (2) by downward movement of the ends, and (3) by the accommodation of a prominent part of the child's head in the interpubic space. With a pubic separation of 7 cm., the total gain in the antero-posterior diameter is about 1.3 cm.; in the transverse the gain is one and a half, and in the oblique about twice as much as in the conjugate.

Technique of the Operation. The woman should be prepared as for an abdominal section. The pubic hair should be shaved, and all

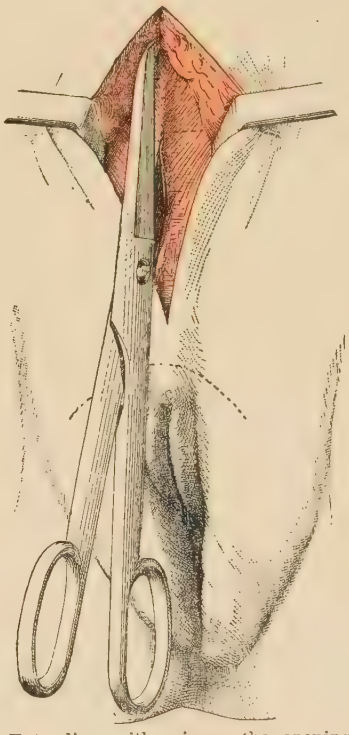
parts in the neighborhood of the field of operation rendered as aseptic as possible. The bladder should be empty. The operation is best delayed, when consistent with safety, until the birth canal has been prepared by nature as far as possible for the passage of the child. The cervix should be fully dilated or dilatable and the vagina should be ample. If dilatation is not complete it should be made so before operation.

The patient is placed upon her back on the table, with the thighs flexed and somewhat everted. This position can be maintained by means of a suitable leg-holder. Two assistants must steady the thighs and prevent undue separation of the lateral halves of the pelvis after section of the symphysis. The exact situation of the symphysis should be determined, and should be indicated by a mark,[1] and it is advisable to draw a transverse line showing the situation of the subpubic ligament,

FIG. 476.

Preliminary incision of the outer covering between the recti with the cutting surface of the scalpel. (FARABEUF.)

FIG. 477.



Extending with scissors the opening made by the scalpel. (FARABEUF.)

which can usually be detected easily by the finger below or to one side of the clitoris. An assistant introduces a full-sized metallic catheter into the urethra. This is depressed as a whole, carrying with it the urethra

[1] A fine camel's-hair brush dipped in tincture of iodine or a solution of silver nitrate serves the purpose.

out of the way of the knife; the catheter serves also at the same time to keep the bladder empty. An incision is made beginning about 3 cm. (1½ inches) above the symphysis and extending downward about 3 inches to the clitoris. The edges of the wound are separated by retractors, and with a few touches of the knife the linea alba is laid bare (Figs. 476 and 477). When the exact position of the symphysis cannot readily be determined, it is well to make gentle traction on the clitoris, the suspensory ligament of which is attached to this point and can be made to serve as a guide. The next step is to separate the suspensory ligament of the clitoris, taking care not to wound the dorsal vessel, and to draw the clitoris down and out of the way, until the lower surface of the arch of the pubes is brought into view. By careful dissection the upper part of the symphysis is next exposed. A finger is then inserted between the recti muscles, and the symphysis is freed posteriorly, the tissues being pushed away from it. A broad, flat, grooved director or guard, strongly bent on the flat, is then inserted under guidance of the finger behind the symphysis, either from above downward or from below upward (Figs. 478 and 479). The function of this guard, which should be kept close to the symphysis, is to protect the tissues behind it from injury. The section of the symphysis may then be made either from within outward (Fig. 480) or, as Farabeuf advises, from without inward. The external ligamentary tissues are first divided, then the periosteum, and finally the cartilage. The periosteum should not be stripped off the bone, except for a very short distance. Other methods of dividing the symphysis may be preferred. After laying bare the joint and opening the linea alba between the recti muscles a thin, probe-pointed, narrow-bladed bistoury, passed downward on a finger as a guide through the abdominal incision, may be employed to sever the joint, the cut being made from behind forward. Galbiati's knife, or Harris's modification of this instrument, may be used instead of a bistoury. Bleeding is controlled and a provisional dressing of sterilized gauze is packed into and over the wound.

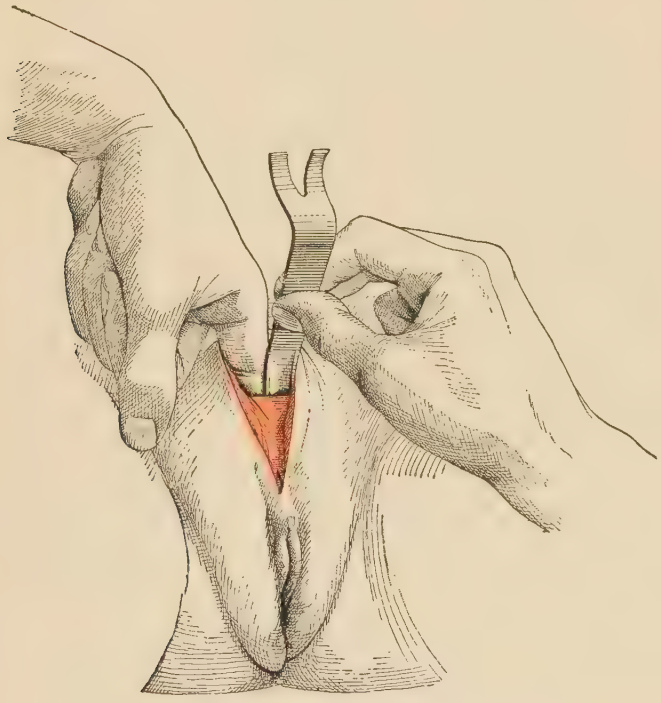
Ayers prefers the following subcutaneous method of dividing the symphysis pubis, and reports four successful cases. The procedure is somewhat as follows: The clitoris having been raised from the symphysis, a narrow, sharp-pointed scalpel is passed beneath it through the mucous membrane from below upward, in the line of the symphysis, to within about half an inch of the upper border of the pubes. The tissues of the joint are then cut through with a straight, blunt-pointed bistoury. In order that the bladder and urethra should not be injured during the procedure they are pushed to one side by means of a sound; at the same time a finger in the vagina controls the blunt point of the bistoury while the tissues of the joint are being divided.

Authorities differ as to whether or not forcible separation of the ends of the symphysis should be made. Some French authors, notably Farabeuf, advise that it be done at once, thus preventing needless compression of the child's head. It would seem more reasonable, with Caruso, to support the hips by a sterile bandage and allow the process to go on more slowly. This plan is attended with less risk of serious laceration of the birth-canal and more nearly approaches the conditions attending a normal labor. The pubic bones should not be

allowed to separate further than 6.5 or 7 cm., 2.5–2.7 inches; if this limit be not exceeded, no great harm can be done at the sacro-iliac joints.

It must be kept in mind that while the separation may be within these limits, it may be due entirely to the downward and outward movement of one side, the other side not partaking in the rotation upon the sacral axis. The danger in allowing a larger amount of separation than 7 cm., 2.7 inches, lies in the fact that the anterior ligaments of the sacro-iliac joints and the tissues in the immediate neighborhood may be very extensively ruptured. A small amount of laceration in these tissues, as has been said, does no harm. If a separation of 7 cm., 2.7

FIG. 478.



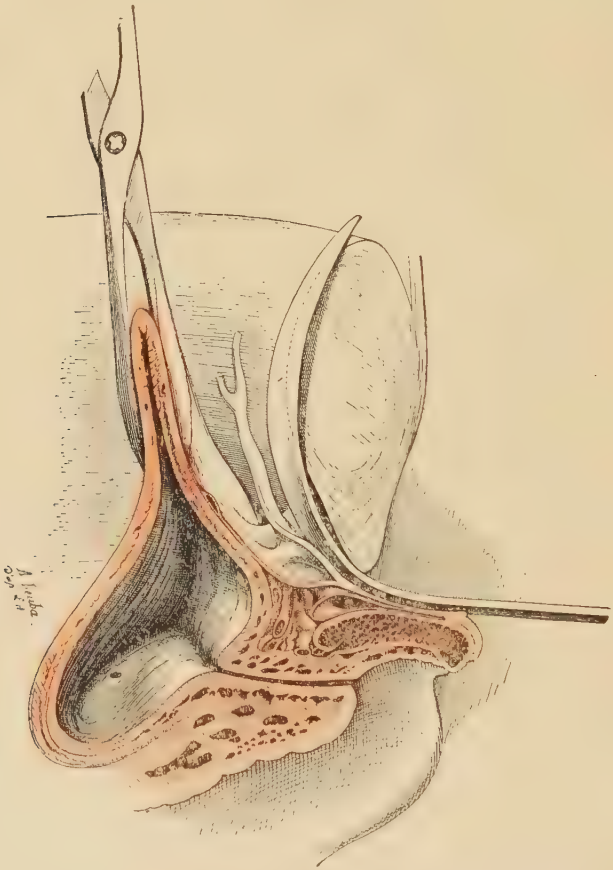
Introduction of the finger and of the grooved guard by the suprapubic route. (FARABEUF.)

inches, or thereabouts is produced, and if this has been accomplished at the expense of one sacro-iliac joint, serious disruption may ensue in this joint, although the total amount of separation at the symphysis be well under the limit. To guard against this the operator should attend personally to the separation at the pubes, and see that both ossa innominata are equally and gently rotated outward. Should one be rotated further out than the other, the situation can readily be detected by observing that one pubic end is lower than the other, whereas they should both be on the same imaginary line drawn perpendicularly to the long axis of the body. Care must be taken, during the passage of the child through the pelvis, that the structures anterior to the birth-canal be protected with due care, especially if any further operative procedures

with the forceps or version be resorted to. It must be remembered that the posterior structures have the support of the sacrum, the coccyx, and the levator ani, but that those situated anteriorly have practically lost their only support.

During delivery it is well to protect the field of operation, more especially the incision and the immediate neighboring parts, from possible infection. This can best be done by packing either plain sterilized gauze

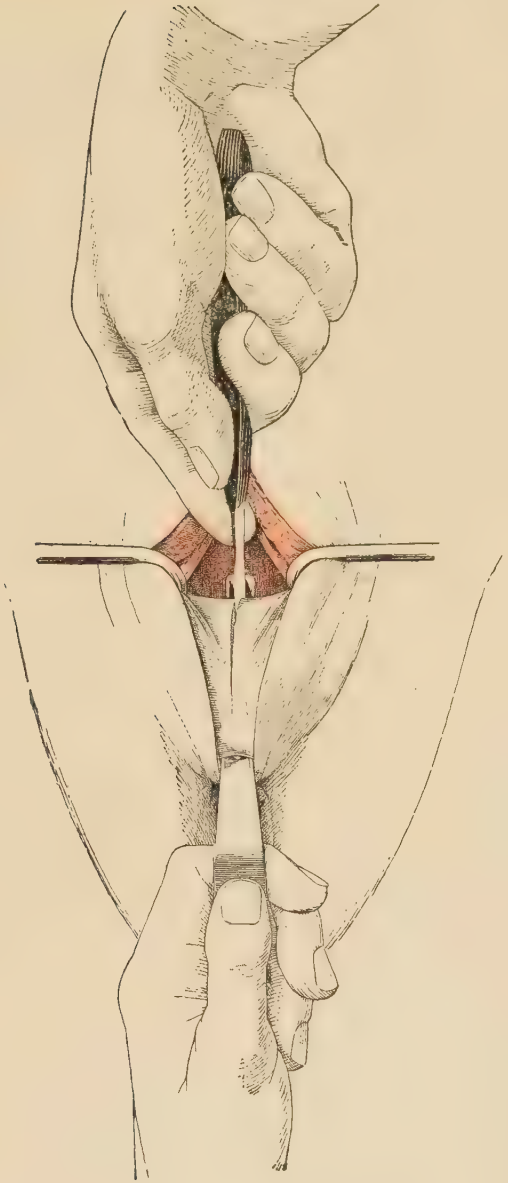
FIG. 479.



The grooved guard passed behind the symphysis, employed to protect the vessels and organs from the knife during the incision. (FARABEUF.)

or iodoform gauze into and around the wound. This dressing can be retained in position by a firm, sterile canton-flannel binder. In fact, this procedure serves several other ends. The gauze packing in the wound, while stopping oozing, or even more active bleeding, gives at the same time considerable support of a yielding character to the bladder, urethra, and anterior structures. The flannel binder serves to support the ossa innominata, and while preventing the divided bones from separating too far, allows them to give enough to permit the passage of the child.

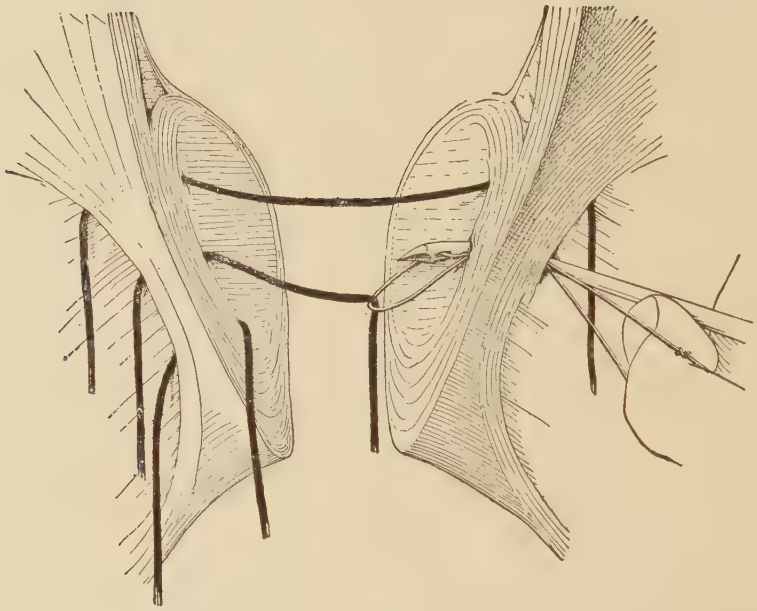
FIG. 480.



Symphysiotomy. The division of the symphysis is accomplished (1) by section between the recti muscles, to sever as far as possible the hard, creaking bundles of the fibrous covering, and to trace in front a line corresponding to the groove of the guard, which is held firmly against the ridge corresponding to the articulation behind. (2) By means of a short, narrow blade with a rounded extremity the operator then cuts through the symphysis from above downward, with the cutting edge of the blade directed forward and under the protection of the grooved guard. (FARABEUF.)

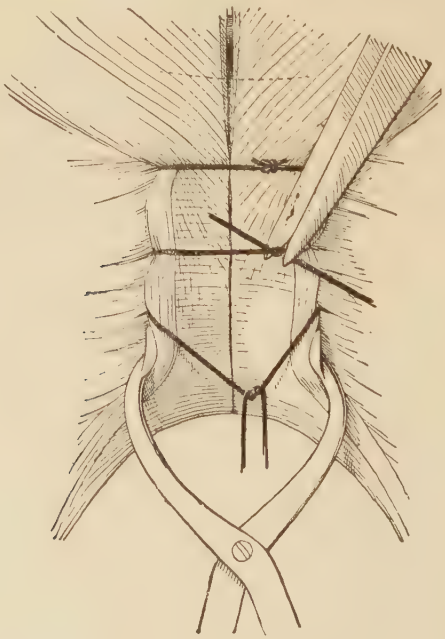
Extraction with forceps is generally advisable if the child is not promptly expelled spontaneously.

FIG. 481.



Mode of introduction of sutures. These should be of strong silk, and should be inserted from the outer borders of the longitudinal bands, keeping close to the bones. It is best to begin on the right side, which presents the greatest difficulty. (FARABEUF.)

FIG. 482.



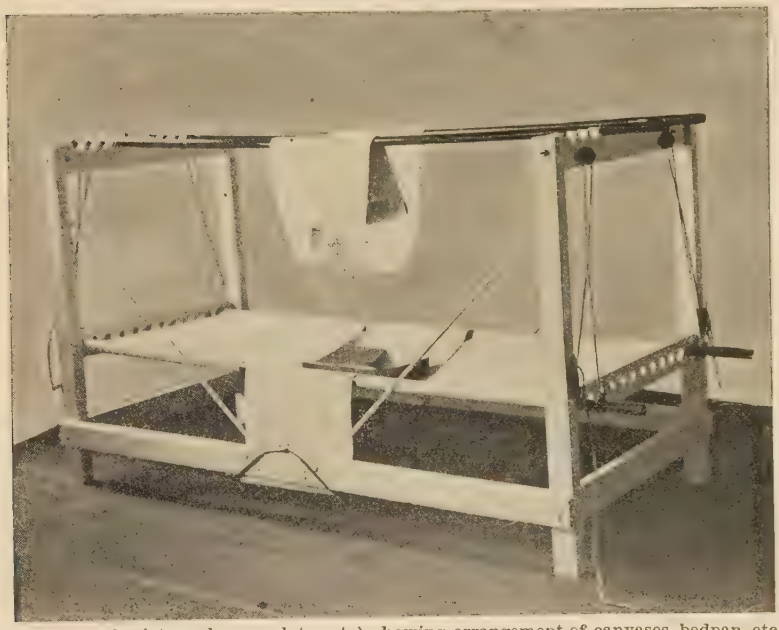
Tying the sutures, while the bones are held in place by Farabeuf's forceps. (FARABEUF.)

After delivery the wound should be closed. Bone sutures are unnecessary and inadvisable. Retention is ensured by suturing the prepubic fibrous structures and applying a firm pelvic binder, especially if coaptation is favored by the use of a trough bed or hammock sling during convalescence.

A simple suture of silk-worm gut embracing all the structures down to the bones, or a crossed or figure-of-eight suture of the same material may be employed. In the latter plan the deep loop of the suture brings together the fibrous structures, and the remaining loop closes the superficial portion of the wound.

If preferred, the aponeurotic structures in front of the bones may

FIG. 483.



Ayers' symphysiotomy hammock (empty), showing arrangement of canvases, bedpan, etc.

be brought together with chromated catgut and the rest of the wound closed in any of the methods usually practised for the abdominal wound.

If the bladder is ruptured, it should be sutured, and careful after-attention given to see that the viscus does not become distended and allow the occurrence of extravasation of urine. In such case the complete or incomplete closing of the external wound must be left to the judgment of the operator.

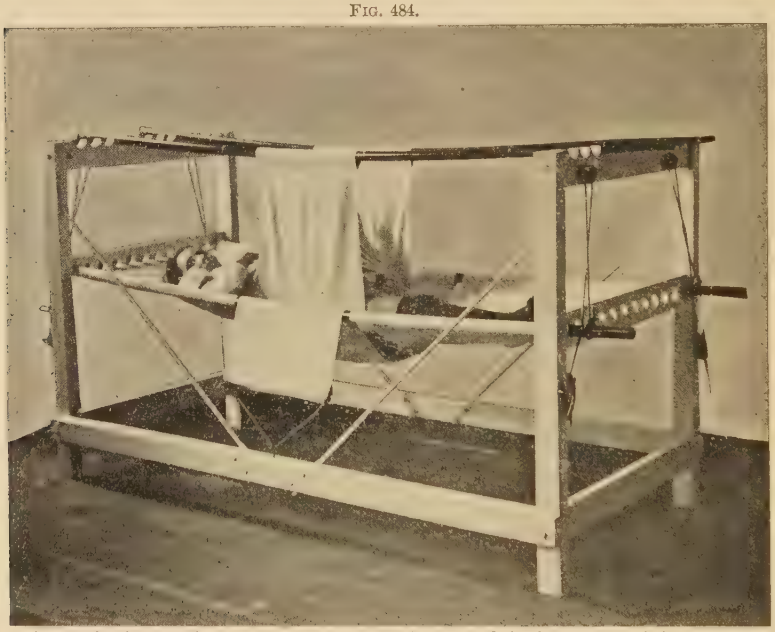
After the wound has been dressed aseptically the pelvis is encircled with two or three firm straps of adhesive plaster which overlap posteriorly. A strong canvas binder is then applied, the bony prominences being protected with padding. The binder needs constant attention to keep it tight. It should be changed if soiled.

Pinard uses a gutter-shaped bed or mattress and places cushions under the lateral halves of the body. Jewett and others have adopted practically the same method, using an ordinary, rather hard mattress and keeping the patient on two firm cushions or sand-bags placed under the lateral halves of the pelvis and extending nearly to the shoulders.

When the bedpan is used the greatest care should be exercised by the nurse to see that no movement on each other of the anterior ends of the bones is permitted. It is best to have ready a strong, intelligent assistant to support the pelvis and gently lift the buttocks while the nurse slips the vessel beneath.

An excellent apparatus for maintaining coaptation of the pubic bones after symphysiotomy is Ayers' hammock-bed. This consists of a

FIG. 484.



Ayers' symphysiotomy hammock, showing patient. Pelvis is supported by upper poles. Lower poles and hammock support head, chest, and limbs, and is adjusted to level of upper hammock.

canvas stretcher supported as shown in Figs. 483 and 484. The stretcher may be made more or less trough-shaped by the adjustment at less or greater distance apart of the poles on which it hangs. A canvas sling wide enough to reach well above and below the pelvis is suspended by its ends from a second pair of poles above the first. When adjusted for use the loop of this pelvic sling reaches the stretcher. The patient rests with her pelvis in the loop of the sling, while the remainder of her body is supported by the stretcher. It will be seen that the pubic bones are held firmly in apposition by the action of the sling, while the upper portion of the body and the lower extremities lie comfortably upon the stretcher.

In the Dresden clinic patients are provided with a pelvic support,

and are allowed to get up after three weeks. It would seem that this is too early to allow the patient to assume the erect position; in any case, it is wiser to keep her fully six weeks in bed, treating the case as one would a pelvic fracture or a fracture of the femur. The pelvic support should not be discarded for several weeks after the woman leaves her bed.

HEBOTOMY.

By hebotomy is meant a modified pubic section in which the body of the os pubis is divided. The side chosen is that on which the occiput lies. An oblique incision is made to one side of the median line along the outer border of the labium majus down to the os pubis. A needle is then passed immediately behind the bone and a Gigli wire saw is hooked to it and drawn through the opening and the bone sawed from behind forward. The separation of the two segments of the pelvic girdle is now possible as in symphysiotomy. After delivery the skin incision is closed and the binder applied. Coaptation of the bones may be maintained by sand-bags.

Doederlein practices subcutaneous pubiotomy as follows: A horizontal incision is made down to the pubic spine. This is lengthened inward until the finger can be passed along the posterior surface of the pubic bone to the lower margin of the descending ramus. A second incision is made on the outer surface of the labium majus, at about the level of the glans clitoridis. The thumb passed through the latter incision meets the finger and the Gigli saw is introduced as in the open method.

This operation has the same limitations as symphysiotomy and many of its draw-backs. The advantages are that it is easier and more rapid. There is less hemorrhage, as the clitoris is not touched. There is less liability of opening the vagina, as the incision is to one side of the vulva and asepsis is more complete. The supports of the bladder, urethra, and anterior vaginal wall are injured less; union between the bony surfaces is more rapid and certain than when the joint is divided; lastly suppuration is less likely to occur. A permanent increase in the size of the pelvis is possible from the formation of callus if the pelvis is not too tightly bandaged. If a subsequent labor ensues the operation can be performed upon the opposite side.

INDEX.

A.

Abdomen, ante-partum examination of, 221
contour of, in pregnancy, 136
enlargement of, in ectopic gestation, 396
examination of, in accidental hemorrhage, 549
in placenta prævia, 541
in pregnancy, 136
in transverse presentation, 502
in uterine rupture, 531
value of, 228
palpation of, in pregnancy, 137
pendulous, with prolapsus funis, 520
preparation of, for cœliotomy, 765
size of, in pregnancy, 137
striæ of, 137
tenderness of, in puerperal endometritis, 631
value of inspection signs, 137
Abdominal binder, 257
in accidental hemorrhage, 550
in post-partum hemorrhage, 553
enlargement in ectopic gestation, 401
examination for abnormal conditions, 228
in pregnancy, 160
incision for Cæsarean section, 766
indication for, 763
intrafœtation, 513
muscles, action of, during labor, 162
pregnancy, 383
signs of, 136
section in rupture of uterus, 533
signs in placenta prævia, 541
stalk, 86
wall during pregnancy, 126
wound, closure of, 769
Abortion, actual, treatment of, 374
cardiac disease a cause of, 586
caused by certain drugs, 365
complete, pathology of, 367
varieties of, 367
criminal, 362
curage *vs.* curettage, relative merits of, 376
curettage, technique of, 379
dangers attending, 372
definition of, 362, 689
diagnosis of, 371
dilation of cervical canal in induction of, 697
diseases of decidua as cause of, 366
Abortion, early, treatment of, 374
embryonic, 362
etiology of, 363
fœtal, 362
causes of, 366
frequency of, 362
habitual, 365
treatment of, 372
hemorrhage at night, 369
incomplete, 367
varieties of, 367
in diabetic women, 584
induction of, 689
Cohen's method, 696
electricity in, 693
Hamilton's method, 694
indications for, 690
Kiwisch's method, 693
Krause's method, 694
method of, 691
Scanzoni's method, 693
Scheel's method, 696
Tarnier's method, 694
inevitable, treatment of, 394
involution of uterus after, 371
late, treatment of, 376
local causes of, 365
maternal causes of, 364
missed, 381
fate of retained child, 381
moles in, 369
treatment of, 381
ovular, 362
paternal causes of, 363
pathology of, 367
premonitory signs of, 370
prognosis of, 372
prophylaxis in pregnancy, 373
protracted, 370
relative size of fœtus, 369
sepsis following, 377
symptoms and clinical course of, 369
therapeutic, 362
threatened, treatment of, 373
time of occurrence of, 363
treatment of, 372
vs. cervical polypus, differential diagnosis of, 372
vs. ectopic gestation, differential diagnosis of, 372
"Abscess de fixation," 650
mammary, in new-born, 664
of broad ligament, 632
of vulva, cause of dystocia, 481
parametritic, treatment of, 647

Abscesses, tubal and ovarian, treatment of, 647
Acardiacus as a cause of difficult labor, 518
Accidental hemorrhage, 548
Accouchement forcé, 544, 576
indication for, in cardiac disease complicating pregnancy, 587
in eclampsia, 576
in placenta prævia, 544
in spasmodic contraction of uterus, 439
Acetic acid in post-partum hemorrhage, 555
Acetone in urine during puerperium, 265
Acetonuria in pregnancy toxæmia, 421
Acini of mammary gland, 67
Action of abdominal muscles in labor, 162
of pelvic floor in labor, 163
Adipocere formation after spurious labor, 405
Adnexa, changes in, due to pregnancy, 124
Adrenalin in hemorrhage, 551
Adrenals, development of, 110
After-pains, 217
cause of, 217
in puerperium, 264
treatment of, 271
Agalactia, 595
Air-hunger, 541
Air, infection from, 620
injection into intestine, 143
Alæ nasi, development of, 106
Albumin in urine following labor, 265
test for, 219
Albuminuria, 420
a cause of puerperal insanity, 599
frequency of, 126
in eclampsia, 561
in triple pregnancy, 517
in twin pregnancy, 515
of pregnancy, 420
Alcohol in post-partum hemorrhage, 555
in puerperal infection, 646
Alcoholism, paternal, a cause of abortion, 364
Alimentary tract, changes in, due to pregnancy, 125
development of, 104
gall-bladder, 108
intestines, 107
liver, 107
mesentery, 107
mouth, 104
œsophagus, 106
pancreas, 108
pharynx, 105
stomach, 106
tongue, 106
Allantoic arteries, 93
Allantois, development of, 86
Amenorrhœa, causes of, 132
diagnostic value of, 131
Amnion, anomalies and diseases of, 322
development of, 84
dropsy of, 322
false, 84
formation of, 84
Amnion, true, 84
Amniotic cavity, 85
fluid, changes in character of, 324
deficiency of, 324
excess of, in prolapsus funis, 520
in version, 730, 732
removal of, to induce abortion, 696
sac, pressure of, on cervix, 202
Amphiaster of ovum, 75
Ampullæ of lacteal ducts, 68
Anæmia, acute, following post-partum hemorrhage, treatment of, 556
signs of, 541, 552
treatment of, 551
contraindication to nursing, 287
in post-partum hemorrhage, treatment of, 556
Anæsthesia, administration of anæsthetic, 249
choice of anæsthetic, 249
for removal of adherent placenta, 702
in repair of vaginal lacerations, 681
in reposition of inverted uterus, 527
in spinal analgesia, 251
in version, 730, 736
obstetric, 248
profound, post-partum hemorrhage from, 267
to relax uterus, 533
Anæsthetic in face presentations, 489
in forceps operation, 710
in occipito-posterior cases, 485
Anæsthetics, administration of, 249
choice of, 249
Anal canal, 31
plate, development of, 107
Anatomy, obstetric, of pelvis, 163
of anus, 30
of bladder, 42
of bulbs of vagina, 25
of carunculæ myrtiformes, 23
of clitoris, 24
of cloaca, 44
of corpus luteum, 53
of cul-de-sac of Douglas, 30
of ducts, *q. v.*
of Fallopian tubes, 45
of fasciæ, *q. v.*
of fœtal head, 179
of fossa navicularis, 20
of fourchette, 20
of glands of Bartholin, 21
of Duverney, 21
of glans clitoridis, 24
of Graafian follicle, 52
of hymen, 22
of ischio-rectal fossa, 30
of labia majora, 18
minora, 19
of ligaments, *q. v.*
of mammary glands, 64
of meatus urinarius, 21
of mons Veneris, 17
of muscles, *q. v.*
of ovaries, 50
of paroöphoron, 53

Anatomy of parovarium, 53
of pelvic fasciæ, 35
floor, 32
of perineal body, 41
ledge, 34
space, 17
of perineum, 18
of recto-vaginal pouch, 30
of rectum, 30
of round ligament of uterus, 18
of soft parts of parturient tract, 176
of the female pelvic organs, 17–70
of triangular ligaments, 34
of urethra, 43
of uterus, 57
of vagina, 26
of vessels and nerves of pudendum, 20
of vestibule, 21
of vulvo-vaginal glands, 22
of white line of pelvis, 35
of Wolffian bodies, 44
Anencephalus, 511, 518
Ano-coccygeal ligament, 32
Anomalies of amnion, 322
of fœtal appendages, 320
of fœtus, 483
of mechanism, 429
of passages, 440
of placenta, 327
Anteflexion of uterus resembling pregnancy, 151
Anterior chamber of eye, development of, 101
commissure, 18
Anteversion of uterus, 476
Antihelix, development of, 104
Antisepsis, chemical agents, 238
choice of methods of, 239
effect of, on puerperium, 629
hands of obstetrician, cleansing, 240
mechanical agents, 237
obstetric, 237
Antiseptic agents, 237
precautions, 241
for the nurse, 242
in version, 730
preparation in vaginal examination, 230
of obstetric patient, 242
Antitoxin, tetanus, 670
Antitragus, development of, 104
Anus, anatomy of, 30
development of, 107
malformations of, 655
vaginalis, 481
Aorta, development of, 91, 93
dorsal, 93
maternal, pulsation of, 141
Aortic arches, 93
bulb, 91
Apoplexy, diagnosis from eclampsia, 562
Appendages, fœtal, anomalies and diseases of, 320
Aqueduct of Sylvius, 98
Aqueous humor, development of, 101
Arbor vitæ uterini, 61
Arch, branchial, 105
visceral, 105
"Area vasculosa" in embryonic circulation, 89
of placenta, 89
Areola, 63
elevation of, during pregnancy, 135
in pregnancy, 133, 135
wrinkling of, 135
Armamentarium, obstetric, 236
Arms, displacement of, in breech presentations, 494
upward displacement of, in breech presentations, treatment of, 497
upwardly displaced, release of, when head is below brim, 498
Arsenic in puerperal insanity, 604
Arteria centralis retinæ, 101
Arteries, allantoic, 93
aortic arches, 93
permanent, 93
carotid, external, 93
internal, 93
carotids, common, 93
dorsal aorta, 93
ductus arteriosus, 93
hypogastric, 94
iliac, 94
of Fallopian tubes, 56
of mammary gland, 68
of ovaries, 57
of pelvic floor, 54
of uterus, 55
of vagina, 55
of vulva, 54
omphalo-mesenteric, 92
subclavian, 93
vertebral, 93
vitelline, 93
Ascites, cause of dystocia, 513
differential diagnosis from pregnancy, 152
fœtal, obstructing labor, 513
vs. pregnancy, 152
Asepsis of the hands, 240, 640
means of securing, 238
Asphyxia in new-born child, causes of, 659
treatment of, 659
Byrd's method, 661
direct insufflation, 660
Laborde's method, 662
Schultze's method, 661
Aspiration in spina bifida, 653
Asynclitism, 209
Atelectasis, 663
Atresia of cervix, 474
Atrophy of decidua, 321
Atropia, oleate of, indication for, 594
Auditory vesicle, 103
Auricular canal in embryonic circulation, 92
Auscultation of abdomen in pregnancy, 139
Auto-infection in puerperal fever, 622
Auto-intoxication in eclampsia, 561
Auto-transfusion, 556

Axis, parturient, 178
Axis-traction forceps, 724
indication for, 718
with ordinary forceps, 719

B.

Bacillary sepsis, 611
in puerperal infection, 611
Bacillus aerogenes capsulatus in puerperal infection, 610
coli communis in puerperal infection, 608
diphtheriæ in puerperal infection, 609
of Döderlein, 29
typhosus in puerperal infection, 611
Bacteria in puerperal infection, 606
Bag of waters, hydrostatic pressure in labor, 202
rupture of, 207
Bags, dilating cervical, method of filling, 544
Ballottement, external, 138
in diagnosis, 138
in ectopic gestation, 402
internal, in diagnosis, 149
Bandl's ring, 533
Barley-water in diluting milk, 298
Barnes' bags, 475, 694
indication for, 494
in dilation of cervix, 696
Bartley incubator, 310
modification of milk, 301
test for urea, 220
Basiotribe, Tarnier's, 757
Basiotripsy, 750
Bath of new-born child, 284
Bathing in pregnancy, 158
Baudelocque, pelvimeter, 443
Bed, preparation of, for labor, 243
Benzoin, tincture of, for sore nipples, 592
Bichloride douche in puerperal endometritis, 645
Binder, abdominal, 257
breast, to prevent mastitis, 594
Birth palsies, 656
Births, plural, 514
complex cases, 515
Bladder, anatomy of, 41
care of, following operations on pelvic floor, 683
conditions of, obstructing labor, 481
cystocele, cause of dystocia, 481
development of, 110
dilation of, in fœtus, 513
distended, retention of placenta from, 700
distension of, 481
after labor, 265
cause of dystocia, 481
in fœtus, 513
secondary hemorrhage from, 558
simulating pregnancy, 153
ectopia vesicæ urinariæ, 352
evacuation of, in second stage of labor, 700
Bladder, injuries to, from forceps operation, 709
irritability of, in pregnancy, 133
ligaments of, 37
maternal, distension of, 139
of new-born child, 281
over-distended *vs.* pregnancy, 153
relation to parturient canal, 177
rupture of, in symphysiotomy, 781
shape of, 43
vesical calculus, cause of dystocia, 482
Blastoderm, development of, 77
Blastodermic vesicle, 77
Blastomeres of ovum, 77
Blebs in puerperal pyæmia, 619
Blood, amount of, lost in normal labor, 217
changes in, during pregnancy, 128
derivation of, 96
diseases of, an indication for induction of abortion, 690
of new-born child, 279
primitive erythrocytes, 96
leucocytes, 96
supply of pelvic floor, 53
Bloodvessels, diseases of, in fœtus, 358
Boiling as a method of sterilization, 238
Bone, injuries to, in new-born child, 656
Bones during pregnancy, 128
Bony pelvis, obstetric anatomy of. *See* Labor.
Boric acid for eyes of new-born, 284
in care of nipples, 590
Bossi dilator, 695
Botalli, duct of, 93
Bougies in induction of labor, 698
Bowels after labor, 265
care of, during puerperium, 265
following operation on perineum, 683
in pre-eclamptic state, 566
irrigation of, in anæmia, 557
in eclampsia, 573
Brain, aqueduct of Sylvius, 98
cerebellum, 99
cerebrum, 98
corpora quadrigemina, 98
crura cerebri, 98
development of, 97
fore-, 97
hind-, 97
injuries in instrumental delivery, 705
medulla, 99
mid-, 97
optic stalks, 98
vesicles, 98
pons Varolii, 98
Branchial arch, structures formed by each, 105
arches, development of, 105
cleft, structures formed by each, 105
clefts, development of, 105
pouches, 105
Braxton-Hicks method of version, 505
Breasts. *See* Mammary glands.
anomalies and diseases of, 589
care of, in pregnancy, 159

Breasts, changes in, in ectopic gestation after fourth month, 401
enlargement of, during pregnancy, 133
mastitis, etiology of, 592
symptoms of, 593
treatment of, 594
normal structure of, 589
pigmentation of, during pregnancy, 133
veins of, 133
Breech deliveries, paralysis sometimes following, 657
delivery in flat pelvis, 455
impaction of, treatment of, 496
non-engagement at the brim, management of, 495
positions, 186
presentation, external version in, 730
Bregma. *See* Fontanelles.
Brim, pelvic, 166
landmarks of, 166
plane of, 166
Broad ligament, hæmatoma of, in ectopic gestation, 398
ligaments, 62
Bromides in puerperal insanity, 604
Bronchi, development of, 108
Broncho-pneumonia, infectious, 633
Brow presentation, diagnosis of, 490
frequency of, 490
head moulding in, 490
management of, 491
mechanism of, 490
Bruit, infantile, 654
Buckmaster's sling, 236
Buhl's disease, 666
Bulbs of vagina, anatomy of, 25
Bulging of corpus uteri in pregnancy, 145
Bursa ovarica, 50

C.

Cæcum, development of, 107
Cæsarean section, 763
absolute indications for, 763
after-treatment of, 769
for carcinoma of cervix with pregnancy, 479
for fibromyoma of uterus with pregnancy, 479
for tumors of vagina obstructing labor, 481
history of, 763
in bicornate uterus, 474
indications for, 763
in cardiac disease complicating pregnancy, 587
relative, 764
in eclampsia, 569
in flat pelvis, 457
in "funnel-shaped" pelvis, 451
in kyphotic pelvis, 469
in malacosteon pelvis, 462
in obliquely contracted pelvis, 459
in placenta prævia, 547
Cæsarean section in scoliotic pelvis, 470
in spasmodic contraction of uterus, 439
in tumors of pelvis, 466
in vaginal enterocele obstructing labor, 481
operation, 765
instruments for, 765
points in technique of operation, 769
preparation for, 765
time for performance of, 765
vaginal, 771
Calcification of fœtus, 356
in ectopic pregnancy, 405
Calculus, vesical, dystocia from, 482
Canal of Nuck, anatomy of, 53
parturient, enlargement of, in symphysiotomy, 774
Caput succedaneum, 183, 214
absence of, with dead fœtus, 356
in brow presentation, 490
in face presentation, 489
Carbolic acid solution as an antiseptic, 239
Carbon dioxide, excess of, in blood a cause of labor, 197
Carcinoma of cervix obstructing labor, 479
of rectum cause of dystocia, 481
of uterus cause of dystocia, 479
hemorrhage from, 558
Cardiac disease complicating pregnancy, 585
symptoms and treatment of, 586
in pregnancy, hygienic treatment of, 586
lesions an indication for induction of abortion, 690
Carotid arteries, origin of, 93
Carunculæ myrtiformes, anatomy of, 23
Casein, effect of excess of, in milk, 293
of sterilization upon, 296
human *vs.* cows' milk, 294
in milk, 293
action of, 293
method of reducing, 302
Case records, method of keeping, 233
Casts, urinary, in toxæmia of pregnancy, 421
Catharsis in eclampsia, 573
Catheterization following repair of vaginal lacerations, 683
indication for, following labor, 269
method of, 270
Cauda equina, development of, 100
Cavity of Retzius, anatomy of, 42
Cephalhæmatoma, 355, 656
treatment of, 656
with large fœtus, 508
Cephalic prominence, fœtal, location of, 226
Cephalometry, 233
Müller's method, 233
Stone's method, 233
Cephalotribe, 757
Cephalotripsy, 757
Cerebellum, development of, 99

Cerebral vesicles, primary, 97
Cervical canal, micro-organisms of, 624
lacerations, reasons for immediate repair of, 688
rings in labor, 206
Cervix, atresia of, obstructing labor, 474
carcinoma of, 479
danger of rapid dilation of, 572
deep incision of, in eclampsia, 569
dilation of, in eclampsia, 569
in forceps operations, 711
in labor, 201
in uterine inertia, 433
to induce abortion, 697
immediate repair of lacerated, 688
impaction of, 475
imperfect dilation of, 577
incisions of, in rapid delivery, 572
injuries to, from forceps operation, 709
lacerated, immediate repair of, 688
laceration of, method of operation for, 688
pregressive softening, 207
purplish hue of, in pregnancy, 144
rapid dilation of, in eclampsia, 569
rigid, treatment of, before rapid delivery, 579
rigidity of, in eclampsia, 572
in spasmodic contraction of uterus, 437
obstructing labor, 474
treatment of, 475
rings of, 206
softening of, 148, 201
undilated, a contraindication to use of forceps, 707
uteri, anatomy of, 57
during first stage of labor, 207
during pregnancy, 123
mucous follicles of, 124
Champetier de Ribes' bag, indication for, 494
balloon in placenta prævia, 544
Child, asphyxia of, following forceps delivery, 710
care of, 256
examination of, at birth, 257
feces of, 308
injuries to, in forceps operation, 709
mortality of, in breech cases, 493
new-born, anatomy of, 277
asphyxia of, 659
bath, 284
clothing, 285
cyanosis of, 654
death of, sudden, 285
diseases of, 664
examination of, 284
feces of, 281
growth of, 283
heart of, malformations of, 654
injuries of, 655
during birth, 655
ligation of cord, 256, 284
malformations of, 652
rectum and anus, 655
Child, new-born, management of, 283
neck of, 278
normal nutrition of, 307
physiology of, 277
respiration of, 279
weight of, 283
nursing of, 272
premature, care of, 309
incubator for, 310
temperature of, 280
thorax of, 278
trunk of, 278
weight chart, 308
Chill in puerperal infection, 631
Chloral hydrate in delayed labor, 435
in eclampsia, 568
in puerperal insanity, 604
in rigidity of cervix, 475
in uterine inertia, 435
Chlorinated soda, antiseptic solution, 239
method of disinfection with, 240
for sterilizing hands, 240
Chloroform, administration of, in labor, 249
in eclampsia, 568
indication for, 586
Chorda dorsalis, 80
Chorion, degeneration of, 324
decidual theory of, 325
diagnosis of, 326
fœtal theory of, 325
ovular theory of, 325
pathology and etiology of, 325
prognosis of, 326
symptoms of, 326
treatment of, 327
diseases of, 324
frondosum, 87
in ectopic gestation, 391
læve, 87
myxomatous degeneration of, 324
primitive, 83
relation to malignant disease of, 326
Chorionic vesicle, 83
Choroid, development of, 101
Choroidal fissure, 101
Circular artery, 55
Circulation, changes in, at birth, 96
disorders of, in pregnancy, 426
embryonic, 89, 96
fœtal, 89
maternal, changes in, due to pregnancy, 123, 128
primitive embryonic, 92
secondary embryonic, 92
utero-placental, 89
Circulus venosus, 69
Circumference of fœtal head, 183
Clavicle, fracture of, at birth, 656
Cleft palate, formation of, 348, 654
Cliseometry, 446
Clitoris, anatomy of, 24
development of, 114
Cloaca, anatomy of, 44
formation of, 107, 345
Clothing in pregnancy, 158
of new-born child, 285

Clots retained in post-partum hemorrhage, 558
Club-foot, congenital, 655
Cocaine in rigidity of os and cervix, 439
Cochlea, development of, 103
Cœlom, 81
Coitus during pregnancy, 159
over-frequent, as cause of abortion, 365
Colic in new-born child, 673
diagnosis of, 673
treatment of, 674
Colles' law, 671
Collyer pelvimeter, 228
Colostrum, 135, 673
action of, on child, 267
composition of, 287
Colpeurynter, 693
in cervical dilation, 699
Colpocystocele, 481
Columnæ vaginæ, 28
Coma in eclampsia, 560
Common bile-duct, development of, 108
Compressor urethræ, 43
Condensed milk, 297
Conjunctivitis in new-born child, 668
Connective tissue of pelvis, 53
Consciousness, loss of, in eclampsia, 560
Constipation during pregnancy, 422
Constitutional diseases as cause of abortion, 364
Constrictor vaginæ muscle, 34
Contour of abdomen in pregnancy, 136
Contractions, intermittent, in diagnosis, 138
uterine, 138, 147, 161, 198
cause of pain, 207
force of, 207
strength of, 162
Convulsions in eclampsia, 559
treatment of, 567
puerperal. *See* Eclampsia.
Cooper, ligaments of, 66
Cord, umbilical, anomalies of, 330
asphyxia from compression of, 659
bibliography of, 331
care of, 284
coil of, about the neck, 330
complicating version, 746
compression of, 507
danger of traction on, 700
hernia of, 330
inflammation of, 330
injury to, in forceps operation, 709
insertion of, 330
interlacing of, in twin births, 517
knots in, 330
length of, 330
ligation of, 256, 284
prolapse of, 520
diagnosis of, 521
etiology of, 520
frequency of, 520
prognosis of, 521
treatment of, 522
Cord, umbilical, reposition of, instrumental method, 522
manual method, 522
shortness of, a cause of dystocia, 507
of inversion, 525
diagnosis of, 508
treatment of, 508
stenosis of vessels, 330
strength of, 508
torsion of, 330
treatment of, in twin births, 515
Cords of Pflüger, 112
Cornea, development of, 101
Cornual pregnancy, 385
symptoms, course, and treatment of, 417
Corona radiata, 73
Corpora quadrigemina, development of, 98
Corpuscles, colostrum, 288
red, number and size of, at birth, 279
Corpus hæmorrhagicum, 73
luteum, 264
anatomy of, 52
spurium, formation of, 73
verum, formation of, 73
Corrugator cutis ani, 30
Cotyledons of placenta, 88
Cranial bones, fracture of, in infant, 656
Cranioclasis, 756
Cranioclast, 756
Craniotomy, 752
and symphysiotomy, 762
extraction following, 755
indication for, 533, 750
is it justifiable on living child, 750
method of operating, 752
on after-coming head, 761
technique of, 752
Cranium of new-born child, 277
Cream mixtures, 299
Credé's method of treatment of adherent placenta, 702
of retained placenta, 700
of expelling placenta, 642
of expression of placenta, 254
solution of silver, 256
Cristæ vaginæ, 28
Crura cerebri, development of, 98
Cul-de-sac of Douglas, anatomy of, 30
Cultures of bacteria from uterus, 637
from vagina, 625
Curage in abortion, 376
Curettage for abortion, dangers of, 380
in abortion, 375
operation of, technique of, 379
Curette in puerperal endometritis, 644
Cuvier, ducts of, 94
Cyanosis neonatorum, cause of, 97, 654
Cyst, cause of dystocia, 481
ovarian, resembling pregnancy, 152
Cystocele, 481
Cysts of Morgagni, 50
of placenta, 329

D.

Date of labor, 155
Dead-born infants, 663
Death, fœtal, diagnosis from asphyxia, 509, 663
of fœtus, 356
of large fœtus, indication for embryotomy, 750
sudden, of new-born child, 285
Decapitation, 507, 758
-hook, Braun's, 759
indication for, 519
in transverse presentations, 507
Decidua, atrophy of, 321
chronic diffuse changes in, 321
glandular hyperplasia, 321
polypoid changes in, 321
diseases of, 320
imperfect development of, 321
inflammation of, 320
in ectopic gestation, 389
menstrualis, 71
reflexa, formation of, 86
serotina, formation of, 87
vera, formation of, 86
loosening of, in labor, 197
Decollation in locked twins, 760
Decollator, Braun's, 759
Deformities, pelvic, detection of, 230
in different races, 176
Delayed labor, 433
Delivery after embryulcia, 500
rapid, bimanual method, 579
dangers of, with rigid cervix, 580
in pre-eclamptic state, 567
methods of, in eclampsia, 569
recent, positive signs of, 275
probable signs of, 276
uncertain signs of, 276
Density of uterus in pregnancy, 147
Descent of fœtus, 208
Development, errors of, in fœtus, 357
of alimentary tract, 104
of clitoris, 114
of external genitals, 113
of fœtus at various months, 115–117
of heart, 90
of new-born child, 283
of nose, 106
of ovum, 73
of penis, 114
of parovarium, 112
of pulmonary organs, 108
of sexual organs, 44
of skeleton, 114
of urogenital system, 108
of uterus, 112
of vagina, 112
of vulva, 114
Diabetes complicating pregnancy, 584
diagnosis, prognosis, and treatment of, 584
Diagnosis of pregnancy, 131
differential, of pregnancy, 151
Diagonal conjugate, 445
Diameter of Baudelocque, 230
Diameter, bisischial, of pelvis, 174
diagonal conjugate, measurement of, 231, 445
external conjugate, 174, 230
in spondylolisthetic pelvis, 464
fœtal, bimastoid, 182
biparietal, 182
bitemporal, 182
cervico-bregmatic, 182
fronto-mental, 182
occipito-frontal, 181
occipito-mental, 181
suboccipito-bregmatic, 182
suboccipito-frontal, 182
intercristal, measurement of, 230
pelvic, external conjugate, 174, 230
oblique, 174
intercristal, 174, 230
internal conjugate, measurement of, 763
interspinal, 174
pubo-coccygeal, measurement of, 231
sacropubic, measurement of, 231
transverse, measurement of, 231
true conjugate, measurement of, 232
Diameters, external, of pelvis, 174
in spondylolisthetic pelvis, 464
of fœtal head, 182
Diaphoresis in eclampsia, 573
in pre-eclamptic state, 566
Diet in pre-eclamptic state, 565
in pregnancy, 157
in preventive treatment of dystocia, 473
of eclampsia, 564
in toxæmia of pregnancy, 425
mother's, while nursing, 286
Digestion, changes in, during pregnancy, 125
disturbances of, in pregnancy, 422
following labor, 267
of new-born child, 280
Digestive juices at birth, 281
organs during pregnancy, 158
maternal, changes due to pregnancy, 125
system in new-born child, 280
Dilation of cervix, 201
digital, 699
mechanism of, 199
of os uteri, rapid methods of, 581
Dilator, Barnes', in rigid cervix, 475
for cervix, 697
Discus proligerus, 52, 72
Disinfection of hands, 640
Dislocation of femora affecting pelvis, 465
Displacement of uterus in puerperium, 275
Diuresis in eclampsia, 573
in pre-eclamptic state, 566
Dorsal aorta, 93
Douche, bichloride, death from, 645
during puerperium, 644
hot, in delayed labor, 436
in puerperal endometritis, 644
intra-uterine, indication for, 702
in post-partum hemorrhage, 555

Douche, intra-uterine, in puerperal infection, 644
vaginal, following repair operations, 687
Drainage in Cæsarean section, 770
Dropsy, amniotic, dyspnœa from, 126
Drugs as cause of abortion, 365
for induction of premature labor, 689, 690
in puerperal insanity, 604
to aid in production of milk, 273
Duct or ducts, cystic, malformations of, 666
galactophorous, 67
hepatic, development of, 108
of Botalli, 93
of Cuvier, 94, 95
of Gartner, 112
of Müller, 44, 110
of Wolff, 108, 110
Ductus arteriosus, 93
Botalli. *See* Ductus arteriosus.
communis choledochus, development of, 108
malformations of, 666
venosus, 96
Dwarfs, pelvis in, 448
Dyspnœa during pregnancy, 126
in pregnancy, 426
from heart lesions, 586
Dystocia caused by ascites, 513
by bladder distension, 481
by brow presentation, 486
by calculus, vesical, 482
by cervix, atresia of, 474
impaction of, 475
rigidity of, 474
by emphysema of dead, 509
by encephalocele, 509
by enlargements or dilations, 513
of head or body by disease, 509
large size of, 508
by enterocele, 481
by face presentation, 486
by fœtus, anomalies of, 483, 507
by hernia, inguinal or crural, 483
by hydromeningocele, 509
by hydrothorax, 513
by kidney, floating, 483
by limbs, prolapse of, 507
by monsters, 518
double, 518
by pelvic presentations, 491
by plural births, 514
by rectum or colon, distension of, 481
by skull, unduly ossified, 508
by transverse presentation, 501
by triplets, 517
by tumors, solid, of vagina or vulva, 481
by uterus, anteversion of, 476
fibromyoma of, 457
in hernial sac, 456
latero-version, 477
polypus of, 479
Dystocia caused by uterus, prolapse of, 477
sacculation of, 477
by vulva, abscess of, 481
œdema of, 480
stenosis of, 480
varicosities of, 480
classification of, causes of, 429
definition of, 429
prevention of, 473

E.

Ear, development of, 103
external, development of, 103
middle, development of, 103
Ecbolics, 691
Eclampsia, causes of, exciting, 562
of fœtal death in, 563
of maternal death in, 563
predisposing, 562
control of convulsions in, 567
curative treatment of, 567
definition, 559
diagnosis of, 562
differential, from apoplexy, 562
from epilepsy, 562
from hysteria, 562
from meningitis, 562
effect on fœtus, 560
elimination of poison, 572
emptying the uterus in, 568
etiology of, 560
frequency of, 559
indication for use of forceps in, 708
in twin pregnancy, 564
pathology of, 562
prodromal period of, 559
prognosis of, 563
stage of coma, 560
of invasion, 559
of tonic and clonic convulsions, 559
symptomatology of, 559
theories concerning cause of, 560
treatment of, 563
curative, 567
preventive, 563
Ectoderm, development of, 78
of ovum, 78
tissues developed from, 80
Ectopia cordis, cause of, in development, 349
Ectopic gestation, 383
abdominal enlargement, 401
pregnancies without rupture, 400
anomalous varieties of, 384
ballottement in, 402
changes in breasts, 401
in placenta, 393
concurrent with uterine gestation, 415
definition of, 383
diagnosis of, 395
after fourth month, 400
of intraperitoneal rupture, 396

Ectopic gestation, diagnosis of, prior to fourth month, 395
differential diagnosis from abortion, 372
disturbances of menstruation, 395
early primary rupture, treatment of, 407
etiology of, 386
extraperitoneal rupture, 398
false or spurious labor in, 404
general conclusions, concerning signs and diagnosis, 402
hæmatocele, 396
hæmatoma in broad ligament, 398
intraperitoneal rupture, 396
treatment of, 407
movements of fœtus, 401
near full term, treatment of, 411
pathology of, 388
pelvic pain in, 395
placental souffle, 402
presence of mass in pelvis, 395
primary extra-peritoneal rupture, hæmatoma, 398
intra-peritoneal rupture, 396
prior to fourth month, general considerations, 395
repeated, 415
secondary rupture, 399
sepsis in, treatment of, 409
subperitoneal rupture, treatment of, 414
symptomatology, after the fourth month, 400
prior to fourth month, 395
traumatic, 417
treatment of, 406
after fourth month, fœtus in abdominal cavity, 413
subperitoneal, 414
general considerations, 411
in septic cases, vaginal incision, 409
unruptured tube, 413
prior to fourth month after rupture, extra-peritoneal, 408
before rupture, 406
general considerations, 406
intra-peritoneal, 407
secondary rupture, 409
after rupture, 407
before rupture, 406
twin, 415
unruptured tubal pregnancy, 400
utero-abdominal or traumatic, 417
vaginal incision in septic cases, 409
varieties of, 383
Ectopic gestation with fœtus in abdominal cavity, treatment of, 413
in unruptured tube, treatment of, 413
subperitoneal, treatment of, 414
Egg-albumin in milk foods, 301
Elasticity of uterus in pregnancy, 147
Electricity for inducing abortion, 693
Embolism following induction of abortion, 696
Embryo at different periods of development, 114
circulation of, 89, 96
development at first month, 114
folding off of, 81
head-folds of, 82
lateral folds of, 82
nourishment of, 87
size of, at second month, 116
at third month, 116
stages in development of, 115
tail-folds of, 82
Embryonic circulation, primitive, 92
secondary, 92
Embryotomy defined, 750
indication for, 533
in spasmodic contraction of uterus, 439
or Cæsarean section, 762
prognosis of, 751, 762
technique of, 752
Embryulcia, 507
for tumors of vagina obstructing labor, 481
in bicornate uterus, 474
in breech presentations, 500
indications for, 489, 496, 508, 517
in flat pelvis, 457
in funnel-shaped pelvis, 451
in obliquely contracted pelvis, 459
in tumors of pelvis, 466
Eminence, ilio-pectineal, 166
Emotional disturbance as cause of abortion, 364
influences in labor, 208
Emphysema of dead fœtus cause of dystocia, 509
Encephalocele, 652
cause of dystocia, 511
Endocarditis in fœtus, 358
Endoderm, 78
structures developed from, 80
Endometritis, chronic, adherent placenta from, 700
diffuse decidual, 325
"diphtheritic," 614
during puerperium, 275
gonorrhœal, 646
mixed infection, 617
puerperal, 614
treatment of, 643
putrid form, symptoms of, 632
septic, 632
Endometrium, formation of, after labor, 263

Enema, administration of, following operations on perineum, 687
saline, in eclampsia, 573
Enlargement of abdomen in pregnancy, 136
Enterocele, cause of dystocia, 481
treatment of, 481
vaginal, 481
Epididymis, development of, 111
Epiglottis, development of, 108
Epilepsy a contraindication to nursing, 287
diagnosis from puerperal eclampsia, 562
Episiotomy in œdema of vulva, 480
operation of, 253
Epispadias, 655
Epoöphoron. *See* Parovarium.
Erector clitoridis, 34
Ergot a cause of abortion, 365
of uterine rupture, 531
after removal of adherent placenta, 702
ecbolic action of, 691
in abortion, 691
in accidental hemorrhage, 550
in delayed labor, 437
indication for, 587
in placenta prævia, 548
in post-partum hemorrhage, 553
in uterine inertia, 437
use of, in third stage of labor, 255
Esbach's test for albumin, 219
Eustachian tube, development of, 103
Eustachius, valve of, 96
Eutocia, definition of, 195
Evisceration, indication for, 514
in locked twins, 760
in transverse presentations, 507
Evolution, spontaneous, in transverse presentations, 504
Examination, abdominal, in abnormal conditions, 228
in labor, 244
method of, 141
record of, 234
ante-partum, 221
record of, 234
bimanual, in ectopic gestation, 402
in pregnancy, steps of, 131
obstetric, abdominal, 221
objects of, 160
preparation for, 136
of child, new-born, 284
pelvic, during puerperium, 275
method of, 143
vaginal, 230
during labor, 247
during pregnancy, 160
in labor, 245
frequency of, 246
in uterine inertia, 435
presence of mass in ectopic gestation, 395
record of, 234
Exercise in pregnancy, 158
Exhaustion from prolonged labor a cause of post-partum hemorrhage, 551
Exomphalos, 514
Exostoses as cause of pelvic deformity, 466
Expelling powers in labor, 161
Expulsion of fœtus, mechanism of, 208
Extension of fœtal head in labor, 212
External carotid arteries, origin of, 93
genitals, changes due to pregnancy, 125
development of, 113
mammary artery, 69
Extraction in craniotomy, 755
in symphysiotomy, 779
Extra-uterine pregnancy. *See* Ectopic gestation.
Extremities, development of, 114
first appearance of, 115
Eye, development of, 100
symptoms in pregnancy toxæmia, 424
Eyelids, development of, 102

F.

Face positions, 186
presentations, 486
abnormal conditions in, 488
diagnosis of, 487
from breech, 493
etiology of, 486
frequency of, 486
head moulding in, 489
management of, 489
mechanism of, abnormal, 488
normal, 488
positions, relative frequency, 486
prognosis of, 487
Facial paralysis from forceps operation, 709
in new-born child, 656
Fallopian tubes, anatomy of, 45
blood-supply of, 56
changes in ectopic gestation, 390
development of, 112
fimbriæ of, 49
mucosa in ectopic gestation, 387
mucous lining of, 49
nerves of, 56
pathological conditions favoring ectopic gestation, 387
vessels of, 56
Fallopius, tubes of, 112
False labor, 404
Faradism for tardy involution, 275
in birth paralyses, 658
in post-partum hemorrhage, 554
Fascia, anal, 40
obturator, 35
pelvic, 35
vesical layer of, 35
recto-vesical, 35
function of, 678
superficial, of perineum, 33
Fat, comparison of, in human and cows' milk, 293
deficiency of, in milk, 301
human *vs.* cows' milk, 294
in milk, effect of sterilization on, 296

Fat resembling pregnancy, 151
Fatty degeneration of new-born, 666
Feces of new-born child, 281
of the infant, 308
Feeding of infant, amount of, 306
artificial, 292
bottle, 292
cream mixtures, 299
forced, 307
frequency of, 306
mixed, 292
modified milk, 295
nursing-bottle, 306
peptonized milk, 306
percentage, 300
requirements of substitute food, 292
table of age interval and amount, 307
of frequency and quantity, 290
variation of food-elements in milk, 293
of new-born child, precautions in, 675
of premature child, 313
substitute, 291
whey mixtures, 301
Fertilization of ovum, 75
Fibroid, submucous, resembling pregnancy, 149
tumor of uterus resembling pregnancy, 151, 152
Fibroma, uterine, secondary hemorrhage from, 558
Fibromyoma of uterus, a cause of dystocia, 477
obstructing labor, 477
treatment of, 478
with pregnancy, diagnosis of, 478
Filum terminale, 99
Fimbria ovarica, 49
Fissures of nipples, 590
treatment of, 590
Flexion of fœtal head in labor, 209
Fœtal anomalies, production of, 335–339
appendages, anomalies and diseases of, 320
development of, 82
causes of abortion, 366
death, 663
development, anomalies of, obstructing labor, 507
exhaustion, an indication for use of forceps, 708
head, abnormal occipito-posterior positions of, 484
approximate diameters of, 182
bones of, 179
changes in diameters of, in labor, 184
circumference of, 183
compression of, with forceps, 705
detached from trunk, delivery of, 724
determination of position of, previous to forceps operation, 711
Fœtal head, diameter of, 182
estimation of size of, prior to application of forceps, 706
extension of, in labor, 212
external rotation of, 213
lateral inclination of, in labor, 210
moulding of, 214
in flat rachitic pelvis, 455
in labor, 183
obstetric anatomy of, 179
occipito-posterior position of, 483
palpation of, 223, 224
planes of, 183
protuberances of, 181
restitution of, in labor, 213
rotation of, experiment of Dubois, 210
of Edgar, 211
size of, for application of forceps, 707
sutures of, 179
unengaged, a contraindication to use of forceps, 707
infection, 355
movements, 138
parts as sign of pregnancy, 149
palpation of, in abdominal examination, 137
pole, lower, palpation of, 223
upper, palpation of, 224
shock, 143
Fœtus, abnormalities of, 332
anomalies of, abnormally large single parts, 351
small single parts, 345
developmental, abrachius, 343
absence of internal organs, 343
or malformation of pelvis and extremities, 343
or stunting of large sections of body, 339
of separate parts, 339
partial, of heart, 345
acardiacus amorphus, 339
acephalus, 339
acheilia, 343
acormus, 339
acrania, 339
acromegalie, 351
aglossia, 343
agnathia, 341
amelus, 343
amorphus, 339
amyelie, 343
anomalous position of parts or organs, 352
aprosopus, 342
apus, 343
arrest of development, 347
arrested development, metamorphosis, 345

Fœtus, anomalies of, developmental, atresiæ, 350
causes of dystocia, 483
cleavage, 347
cranial and vertebral, 348
intestinal, 349
of chest and abdomen, 349
of lips, jaw, and palate, 348
vesical, 349
cloaca formation, with abdominal and vesical cleavage, 349
with closed bladder, 349
with vesical cleavage, 349
club-foot, varieties of, 350
congenital luxations, 350
craniopagus, 351
cranioschisis, 348
cretinismus, 340
cryptorchismus, 350
cyclopia, 340
dextrocardia, 352
dicephalus, 351
diprosopus, 351
dipygus, 351
diverticula, 350
diverticulum, Meckel's, 350
duplication of upper and lower ends of bodies, 351
dwarfs, 345
dystopiæ of separate organs, 352
ectopia cordis, 352
vesicæ urinariæ, 352
engastrius, 352
epigastrius, 352
epignathus, 352
epispadias, 349
fissura abdominalis, 353
fistula coli congenita, 348
fœtus in fœtu, 352
from arrested development, 345
fusion of kidneys, 345
gastroschisis, 349
genital organs, arrested development of, 346
giants, 351
hare-lip, 348
hemicrania, 339
hermaphrodites, 346
hermaphroditism, 346
hernia diaphragmatica congenita, 353
peritonealis congenita, 349
hydrencephalocele, 348
hydrencephalus, 351
hydrocephalus, 351
hypertrichiasis, 351
ischiopagus, 351
Fœtus, anomalies of, developmental, janiceps, 351
luxations, congenital ,350
macrocephalus, 351
macrodactylia, 351
macroglossia, 351
macrosomia, 351
malformations of face, 342
of vertebral column, cord, chest, 342
microbrachius, 343
microcephalus, 339, 345
micromelus, 343
micropus, 343
microsomia, 345
monobrachius, 343
monopus, 343
monstra duplicia, 351
per defectum, 339
per excessum, 351
per fabricam alienam, 352
triplicia, 352
mylacephalus, 339
nansomia, 345
of heart, 345
organs, absence of, 343–345
over-large development, 351
pathological conditions causing, 335, 337
pathology of, 339
perobrachius, 343
peromelus, 343
peropus, 343
phocomelus, 343
polydactylie, 352
polymelia, 352
prosopothoracopagus, 351
parasiticus, 342
pyopagus, 351
rachipagus, 352
rachischisis, 348
single parts, abnormally small, 345
situs transversus, 352
spina bifida, 348
supernumerary extremities, 352
formation, 351
organs, 352
polydactylie, 352
polymelia, 352
sympus, 343
syncephalus, 351
syren formation, 343
talipo-manus, 350
terata anacatadidyma, 351
anadidyma, 351
catadidyma 351
thoracopagus (Siamese twins), 351
thoracopus parasiticus, 352
uterus duplex, 347
unicornis, 347
appendages of, development of, 82
at different periods of development, 115

Fœtus, attitude of, 186
calcification after spurious labor, 405
cerebral hemorrhages in, 355
circulation of, 89
circumference of head of, 183
conditions of, indicating forceps, 708
dead, absorption from, 509
a contraindication to use of forceps, 707
emphysema of, 509
death of, 663
an indication for induction of abortion, 690
calcification, maceration, mummification, putrefaction, 356
diagnosis of, 356
in placenta prævia, 542
delivery of trunk of, 213
descent of, in labor, 208
development of, at first month, 115
diagnosis of death of, 356
diseases of, 354
cephalhæmatoma, 355
classification of, 354
fœtal infection, 355
heredity, 354
inflammation of, 355
primæ viæ, 359
effect of eclampsia upon, 560
enlargement of head or body of, by disease, 509
errors in development of, 356
flexion of head of, in labor, 209
head, circumference of, 183
diameters of, 181
measurements of, 181
moulding of, 184
in labor, 214
obstetric anatomy of, 179
planes of, 183
heart, auscultation of, 226
diagnosis of location of, 227
heart-sounds of, 139, 141
hemorrhage of, 355
hereditary disease of, 354
infectious diseases of, 355
inflammation of, 355
in uterine inertia, 435
large size of, cause of dystocia, 508
length of, in last months of pregnancy, 155
location of back and small parts of, 221
malnutrition of, 356
malposition of head of, obstructing labor, 483
management of birth of trunk, 253
mature, length of, 184
weight of, 184
mensuration of, in determining date of labor, 154
method of expulsion, 208
mortality of, in precipitate labor, 432
moulding of, in breech presentations, 494
movements of, in diagnosis, 138
in ectopic gestation, 401
Fœtus, mummification of, after spurious labor, 405
palpation of, in pregnancy, 149
papyraceus, occurrence of, 317
parts of, in diagnosis, 137
pathology of, 332
rotation of head of, in labor, 210
size of, at different stages, 116
systemic organic lesions, 357
treatment of anomalies of, obstructing labor, 514
trunk, diameters of, 184
viability of, 362
weight as a criterion, 362
weight of, 508
at different stages, 116, 117
Folding off of the embryo, 81
Folds of Douglas, 30
Follicles of Montgomery, 135
Fontanelles, 179
at birth, 277
closure of, 509
false, 180
temporal, 180
Food, nitrogenous, in pre-eclamptic state, 565
Foramen of Munro, 98
ovale, 92, 96
closing of, at birth, 96
Forceps, 703
application of, 712
in flat pelvis, 456
to after-coming head, 723
to breech, 723
axis-traction, 724
advantages of, 726
Galabin's, 724
Hubert's, 724
indication for, 486, 727
in obliquely contracted pelvis, 459
Jewett's, 727
Lusk's, 726
operation with, 727
Simpson's, 726
Tarnier's, 725
blades, removal of, 703
cephalic application of, 715
Chamberlen, 703
contraindication to use of, 706
extraction with, for prolapse of cord, 523
high operation, 717
in median operations, 721
low operation, 716
function of, 705
handles of, 703
high application of, in occiput-posterior cases, 485
in breech cases, 723
indications for, 489, 515, 523, 533, 550, 707
in face presentation, 723
in funnel-shaped pelvis, 451
in justo-minor pelvis, 450
in occipito-posterior positions, 721
in pelvic presentations, 499

Forceps in uterine inertia, 437
invention of, 703
lock of, 704
low application of, in occiput-posterior cases, 486
obstetric, 703
application of, 712
Barnes', 705
blades of, 704
Braun's, 705
cephalic curve of, 704
compression with, 706
contraindication to use of, 706
direct traction with, 706
Dubois', 705
fenestration of, 704
function of, 705
handles of, 703
Hodge's, 705
indications for use of, 707
Jewett's, 705
lever action of, 706
lock of, 703
material of, 703
Naegele's, 705
Pajot's, 705
pelvic curve of, 704
prerequisites to use of, 706
rotative action of, 705
shanks of, 704
short, straight, 704
Simpson's, 705
Wallace's, 705
operation, 712
amount of tractile force in, 719
cephalic application, 715
dangers of, 709
extraction in, 715
general rules in, 720
high, 712
introduction of first blade, 713
of second blade, 714
line of pull in, 718
locking, 714
low, 712
median, 712
posture of patient in, 711
preparation for, 710
steps of, 713
traction in, 716
Palfyn, 703
paralysis caused by pressure of, 658
pelvic application of, 713
Poullet's, 724
rupture of symphysis pubis from, 534
Smellie's, 703
to after-coming head, 723
value of, compared with symphysiotomy and version, 749
with malacosteon pelvis, 465
Fore-gut, development of, 82
Fornix of vagina, 26
Fossa, ischio-rectal, anatomy of, 30
navicularis, anatomy of, 20
Fourchette, anatomy of, 20
rupture of, 679
Fowler's position after vaginal section, 410
Frænulum, anatomy of, 19
of labia minora, 19
pudendi. *See* Fourchette.
Freeman pasteurizer for milk, 297
Frontal protuberance, 181
Fundus uteri, anatomy of, 57
location of, by abdominal examination, 137
Funis, presentation of, 520
reposition of, 522
Fürbringer method of disinfection, 240
Furrows of uterus in pregnancy, 147

G.

Galactocele, 596
treatment of, 596
Galactorrhœa, 596
Gall-bladder, development of, 108
Gartner, duct of, 112
Gavage in infant feeding, 307
Gelatin-water in diluting milk, 298
Genital fold, 111
groove, 113
labium, 113
organs, diseases of, in fœtus, 360
tubercle, 113
Genitalia, care of, in puerperium, 271
diseases of, in fœtus, 360
Genitals, cleansing of, for forceps operation, 710
external, development of, 113
during pregnancy, 125
Germinal epithelium, 51, 111
spot, 74
vesicle of ovum, 74
Gill arches. *See* Branchial arch.
clefts. *See* Branchial clefts.
Gingivitis in pregnancy toxæmia, 424
Glands, Bartholin's, anatomy of, 21
Duverney's, 21
mammary, anatomy of, 64
of Montgomery, anatomy of, 65
Skene's, anatomy of, 44
thymus, development of, 105
vulvo-vaginal, 22
Glandulæ vestibuli minores, 21
Glans clitoridis, anatomy of, 24
Glomeruli, development of, 110
Glonoin in eclampsia, 573
Glottis, development of, 108
Gloves, operating, 241
Glycosuria during pregnancy, 584
Gonococcus in puerperal infection, 608
Graafian follicle, anatomy of, 52
development of, 72
Guthrie's muscle, 43

H.

Habitual abortion, 366
Hæmatocele in ectopic gestation, 396
Hæmatoma of broad ligament, 398
of vagina, 535
of vulva, 535
cause of dystocia, 480
symptoms and treatment of, 536, 537

Hæmatometra, 139
simulating pregnancy, 153
Hæmophilia, post-partum hemorrhage caused by, 552
prenatal, 355
Haines' method of computing urinary solids, 219
Hammock-bed, Ayres, 535, 782
Hand, prolapse of, 503
Hands, cleansing of, 240, 710
disinfection of, 640
Hare-lip, formation of, 348, 654
Hart's law, 484, 488
Head-bend, primary, 97
Head, constriction of, by uterus in breech presentation, 498
delivery of, in podalic version, 747
extraction of, in breech cases (Smellie method), 499
forceps extraction of, in breech presentation, 499
impaction of, in breech presentation, 494, 499
malposition of, 483
malrotation of, in breech presentation, 501
manual extraction of, in breech presentation, 499
-moulding, absence of, in ossified skull, 508
in brow presentation, 590
in contracted pelvis, 449
in face presentation, 589
in justo-minor pelvis, 449
in occiput-posterior cases, 484
occiput-posterior, cause of dystocia, 483
Heads, fœtal, detection of, in multiple pregnancy, 318
Heart, anomalies of development of, 345
auricular canal of, 92
cardiac disease, complicating pregnancy, 585
treatment of, 586
changes in, during pregnancy, 126
development of, 90
of foramen ovale, 92
of septum inferius, 92
superius, 92
of truncus arteriosus, 92
diseases of, in fœtus, 358
embryonic, size of, at first month, 116
fœtal, causes of inaudibility of, 141
examination of, 141
focus of auscultation of, 139
heart-sounds in pregnancy, 139
location of, 226
sounds of, 139
infantile, congenital malformations of, 654
lesions of, in pregnancy, 585
malformation of, in new-born, 654
of new-born child, 279
physiological hypertrophy of, 585
-sounds, feebleness of, 323
fœtal, 116
in pelvic presentation, 492
Heart-sounds, feebleness of, in transverse presentation, 503
two, in plural pregnancy, 318
stimulants, use of, in cardiac disease complicating pregnancy, 587
symptoms of valvular disease of, 586
valvular disease of, complicating pregnancy, 585
Heat, dry, for antisepsis, 237
moist, for antisepsis, 238
Hebotomy, 783
Hegar's sign in diagnosis, 145.
Helix, development of, 104
Hemicephalus, 511, 518
Hemiplegia from forceps operation, 709
in new-born infant, 658
Hemispheres, cerebral, development of, 98
Hemoglobinuria, infectious, in new-born, 667
Hemorrhage, accidental, 539, 548
apparent, 549
diagnosis from placenta prævia, 541, 549
diagnosis of, 549
etiology of, 548
prognosis of, 549
treatment of, 550
varieties of, 548
concealed, 549
as cause of abortion, 367
at night only, in certain cases of abortion, 370
cerebral, in new-born infant, 658
following abortion, 372
from circular artery, 688
from uterine contractions, 197
in abortion, 370
in ectopic gestation, 392, 403
in fœtal disease, 358
in fœtus, 355
in placenta prævia, 539
control of, 543
in thrombosis of vulva, 535
intracranial, at birth, 656
from forceps operation, 709
of placenta prævia, 539
post-partum, 551
diagnosis of, 552
etiology of, 551
frequency of, 551
in placenta prævia, 548
in twin births, 515
preventive treatment of, 553
prognosis of, 553
relation to pelvic deformity, 473
treatment of, active, 553
prophylaxis, 553
secondary, 557
with justo-major pelvis, 447
with tumors of uterus, 477
renal, in fœtus, 360
secondary post-partum, 557
source of, 539
umbilical, in child, 664
unavoidable, 539
uterine, 539

Hemorrhage, uterine, demanding use of forceps, 708
following precipitate labor, 432
in false labor, 404
on death of fœtus, 381
varieties of, 539
Hemorrhagic diathesis, post-partum hemorrhage from, 552
diseases of new-born, 667
Hemorrhoids in pregnancy, 426
Henson's node, 80
Hepatic ducts, development of, 108
Hepatitis, interstitial, 666
Heredity in diseases of fœtus, 354
in puerperal insanity, 598
Hermaphrodites, false, 346
true, 346
Hernia, including uterus, cause of dystocia, 476
inguinal, crural, cause of dystocia, 483
navel-cord, 330
of uterus, 476
umbilical, in fœtus, 514
in new-born child, 654, 665
Herniæ, external abdominal, 349
inguinal or crural, obstructing labor, 483
internal abdominal, 349
varieties of, in maldevelopment, 349
Herpes in pregnancy, 425
Hind-gut, development of, 82
Hirst, measurements of pelvis, 445
pelvimeter, 232
Holoblastic segmentation of ovum, 77
Holt incubator, 312
Hot-air bath, 566
Hot pack, 566
water in post-partum hemorrhage, 555
Humerus, fracture of, at birth, 656
Hydatidiform mole, 324
Hydatids (cysts) of Morgagni, 50, 111
Hydræmia in eclampsia, 562
Hydramnios, 322
differential diagnosis of, 323
etiology and symptoms of, 322
frequency of, 322
in multiple pregnancy, 318
in plural births, 515
post-partum hemorrhage from, 552
prognosis and treatment of, 323, 324
Hydrencephalocele, 653
Hydrocephalus, 509, 652
cause of dystocia, 509
development of, 351
in fœtus, diagnosis of, 511
prognosis of, 512
relation of, to labor, 512
treatment of, 512
Hydromeningocele, 509
cause of dystocia, 509
Hydronephrosis, fœtal, 360, 513
Hydrorrhachis, 514
Hydrorrhœa amnialis, 321
deciduale, 321
gravidarum, 321
diagnosis from hydramnios, 323
Hydrothorax cause of dystocia, 513
fœtal, obstructing labor, 513
Hygiene of pregnancy, 157
Hymen, anatomy of, 22
tears of, 260
varieties of, 22, 23
Hyoid bone, development of, 105
Hyoscin hydrobromate in puerperal insanity, 604
Hyperæmia, cerebral, in eclampsia, 562
Hyperemesis gravidarum, 423
Hyperlactation, 597
Hypochlorous acid method of antisepsis, 241
Hypogastric arteries, origin of, 94
Hypospadias, congenital, 655
Hysterectomy for inversion of uterus, 527
indication for, 527
in puerperal infection, 647
Hysteria, contraindication to nursing, 287
diagnosis from eclampsia, 562

I.

Ice in mastitis, 595
in post-partum hemorrhage, 554
Ichthyosis, fœtal, 361
Icterus neonatorum, 665
grave form, 666
mild form, 665
'true,' 665
Idiocy from forceps operation, 709
Iliac arteries, origin of, 94
Immature labor. *See* Abortion.
treatment of, 378
Impregnation of ovum, site of, 75
Incubation for premature children, 310
period of, 313
Incubators, 310
temperature of, 310, 311
Indicanuria in pregnancy toxæmia, 421
Inertia uteri, 433
indication for forceps in, 708
in twin births, 514
retention of placenta from, 700
Infant mortality with prolapsus funis, 521
dead-born, 663
new-born, cyanosis of, 654
over-feeding of, 306
premature, care of, 309
feeding of, 313
still-born, 663
stools of, 308
weight-chart of, 308
weight of, at birth, 308
Infarcts of placenta, 328, 329
Infection, auto-, 622
fœtal, 355
intra-partum, 634
maternal, from dead fœtus, 356
puerperal, 605
from gas bacillus, report of a case, 610
umbilical, 667
Infectious diseases as cause of abortion, 364
Inferior strait, 166

Infundibular pregnancy, 383
Infusions, saline, after post-partum hemorrhage, 556
Injuries of new-born child, 655
to bone and muscles, 656
Insanity, puerperal, 598
etiology of, 598
forms and symptoms of, 599
prodromal period of, 600
prognosis and treatment of, 602
Inspection of abdomen in diagnosis, 136
Instruments for repair of vaginal lacerations, 681
sterilization of, 238
Insufflation, direct, in asphyxia, 660
Inter-brain, 98
Intercourse, sexual, during pregnancy, 159
Intermittent contractions of uterus in diagnosis of pregnancy, 146
Interstitial pregnancy, 383
Intestinal fermentation in new-born child, 673
Intestine, development of, 107
Intestines of new-born child, 280
Intraspinal cocainization, 251
Intravenous injection of salt solution in post-partum hemorrhage, 556
Introitus vaginæ, 21
Inversion of uterus, complete, 523
etiology of, 524
frequency, 523
partial, 523
prognosis and treatment of, 526
symptoms of, 526
treatment of, 526
Involution in abortion, 371
tardy, 274
Iris, development of, 101
Iron in pre-eclamptic state, 566
in puerperal insanity, 604
Ischio-bulbosus muscle, 34
-cavernosus muscle, 34
-rectal fossa, anatomy of, 30
Ischium, spine of, as an obstetric landmark, 167
tuberosities of, 167
Islands of Pander, 89
Isolation in treatment of puerperal insanity, 603

J.

Jaundice, 666
in pregnancy toxæmia, 424
Jewett sign of pregnancy, 144
Joints, pelvic, mobility of, 166
sacro-coccygeal, 164
sacro-iliac, 164
symphysis pubis, 165
Justo-major pelvis, 447
-minor pelvis, 448

K.

Karyokinesis, 76
Kidney, development of, 110
Kidneys, changes in, due to pregnancy, 126
diseases of, in fœtus, 360
Kidneys, diseases of, in puerperal eclampsia, 560
floating, cause of dystocia, 483
horse-shoe formation, 345
of new-born child, 282
Knee-chest position in threatened abortion, 374
Knife of Galbiati, 776

L.

Labia majora, anatomy of, 18
development of, 114
minora, anatomy of, 19
changes produced in, 20
development of, 114
frænulum of, 19
præputium of, 19
Labium, abscess of, 481
Labor, abdominal examination in, first stage, 244
accidental, complications of, indicating forceps, 708
action of abdominal muscles in, 162
of pelvic floor in, 163
anæsthesia in, 248
anomalies of, arising from accidents or disease, 520
mechanism, 429
of the passages, 440
cardiac disease an indication for induction of, 585
causes of onset of, 196
cervical rings in, 206
clinical phenomena of beginning, 198
complicated by placenta prævia, 538
definition of, 195
delayed, 433
causes of, 433
prognosis of, 435
symptoms of, 434
treatment of, 435
diagnostic signs of beginning, 244
difficult, anomalies of soft parts, 474
pelvic deformities in, 440
dilation of cervix, mechanism of, 199
duration of, 195
effect of diabetes on, 584
of eclampsia on, 560
expelling powers, abdominal muscles, 162
contraction of uterus, 161
strength, 162
force of uterine contractions, 162
pelvic floor action, 163
uterine changes in shape and position, 162
face presentations, 486
false or spurious, in ectopic gestation, 404
final duties of physician, 258
first stage, bladder and rectum, 207
emotional influences, 208
management, 244
pains, 207

Labor, first stage, preparation of patient for, 244
pulse, 207
secretions, 207
show, 207
thinning of cervix, 207
following operations for uterine displacements, 477
general rules in management of, 247
hemorrhages in, 538
hydrostatic pressure in, 202
immature, treatment of, 378
in bicornate uterus, 474
in compressed pelvis, 461
induction of, in eclampsia, 569
in hydramnios, 324
in pre-eclamptic state, 566
influence of contracted pelvis on, 449
in kyphotic pelvis, 467
in scoliotic pelvis, 469
in twin births, 514
irregularity of action of uterus in, 437
management of, 219
first stage in, 244
in birth of trunk, 253
in brow presentation, 491
in face presentation, 489
in multiple pregnancy, 318
in occipito-posterior cases, 485
in pelvic presentation, 494
in placenta prævia, 542
in plural births, 515
in second stage, 247
in transverse presentation, 505
mechanical elements of, 161
mechanism of, 195
anomalies, 429
of expellent forces, 431
in brow presentation, 490
in face presentation, 488
in flat rachitic pelvis, 454
in obliquely contracted pelvis, 459
in occipito-posterior position, 483
in pelvic presentation, 493
main factors in, 429
with large fœtus, 508
method of keeping history of, 234
missed, 381
fate of child in, 381
treatment of, 381
normal, 195
definition of, 195
duration of, 195
nurse's preparation for, 243
occiput-posterior cases, operative procedures in, 485
pains of, 207
passages in, parts of pelvis, 164
pelvis, bony, obstetric anatomy of, 163
brim of, 166
false, 166
joints of, 164
sacro-coccygeal, 164
sacro-iliac, 164
symphysis pubis, 165

Labor, passages in, pelvis, true, 166
pathology of, 429
perineal stage, management of, 251
physiology of, 161
positions during, 247
precipitate, 431
causes of, 431
post-partum hemorrhage following, 552
sequelæ of, 432
treatment of, 432
prediction of date of, 155
premature, 382
causes of, 382
definition of, 362, 689
induction of, 689
in obliquely contracted pelvis, 459
methods of, 698
operation of, 698
in multiple pregnancy, 318
treatment of, 382
prematurity of, in plural births, 517
preparation for, 243
of bed for, 243
of patient for, 242
of room for, 242
preparatory treatment for, 219
probable date of, 155
prognosis, in normal, 246
prolonged, central paralysis from, 658
record of, 234
retraction of pelvic floor in, 206
second stage of, 208, 214
clinical phenomena of, 214
delivery of trunk in, 213
descent in, mechanism of, 208
examination during, 247
extension in, mechanism of, 212
external rotation in, mechanism of, 213
flexion in, mechanism of, 209
management of, 247
moulding of head in, 214
restitution in, mechanism of, 213
rotation in, mechanism of, 210
spasm of uterus in, 437
causes of, 437
diagnosis of, 438
prognosis of, 438
treatment of, 439
spurious, changes after, 404
in ectopic gestation, 404
stages of, 195
third stage of, clinical phenomena of, 216
management of, 254
uterine contractions in, 161
retraction in, 200
vaginal examination in first stage, 245
walking about in first stage, 246
with contracted pelvis, 440
treatment of, 450
with fœtal monstrosity, 519
with "funnel-shaped" pelvis, 451
with justo-major pelvis, 447
with justo-minor pelvis, 449

Labor with pelvic anomalies, 451
with spondylolisthetic pelvis, 465
Laceration of cervix, repair of, 681
immediate, 688
of perineum, immediate suture of, to prevent infection, 643
vaginal, 677
character of injury, 678
combined internal and external tear, 680
complete, 684
immediate repair of, 677
walls, 260
vulvar, 677
complete, 684
immediate repair of, 677
superficial external, 679
Lactation, 267
during puerperium, 267
length of period of, 268
termination of, 273
Lactose during pregnancy, 584
Lanugo, 282
disappearance of, 117
Larynx, development of, 108
Laxatives for use in pregnancy, 158
Lead-poisoning a cause of abortion, 364
Leucocytosis, artificial, in puerperal infection, 651
Levator ani, action of, 677
anatomy of, 38–40
Ligament, ano-coccygeal, 32
broad, development of, 112
(mesosalpinx), anatomy of, 46
greater sacro-sciatic, 167
infundibulo-pelvic, 46
interosseous, 164
lesser sacro-sciatic, 167
of bladder, 37
of Cooper, 66
of ovaries, 53
of pelvis, 164
of uterus, 62
pubic, 165
round, of uterus, 53
rigidity of, 139
sacro-iliac, 164
sacro-sciatic, greater, 167
lesser, 167
relation to pelvic outlet, 167
suspensory, of ovary, 46
triangular, 34
anatomy of, 37
uterine, anatomy of, 53, 62
utero-sacral, 30
Ligamentum arcuatum, 166
Ligation of cord, 256, 284
'Lightening," 136
Limbs, fœtal, prolapse of, 507
Lineæ albicantes, 137
Liquor amnii, 207
composition and function of, 85
folliculi, 72
secretion of, 85
Lithopedion, 405
Liver, abnormal location of, 353
circulation of, in embryo, 95
Liver, development of, 107
diseases of, in fœtus, 360
during pregnancy, 126
of new-born child, 281
tumors of, obstructing labor, 483
Lobe of ear, development of, 104
Local causes of abortion, 365
conditions to be treated in puerperal insanity, 603
Location of anterior shoulder, 225
of cephalic prominence, 226
of fœtal back and small parts, 221
heart, 226
Lochia, 264
alba, 264
amount of, 264
bacteriological examination of a series of cases, 613
effect of stoppage of, 599
in abortion, 371
in puerperal infection, 631
rubra, 264
serosa, 264
stoppage of, in puerperal insanity, 599
Löhlein measurement of pelvis, 445
Lordosis deforming pelvis, 470
Lozenge of Michaelis, 444
Lubricants, 241
Lungs, development of, 107
diseases of, in fœtus, 359
of new-born child, 279
Lutein, 73
Lying-in chamber during puerperium, 271
preparation of, 242
Lymphangitis, puerperal, 619
Lymphatic system in embryo, 97
Lymphatics, diseases of, in fœtus, 359
of mammary gland, 70
of new-born child, 282
of pelvic floor, 54
of pudendum, 20

M.

Maceration of fœtus, 356
Magnesium sulphate to induce abortion, 692
Major operations as cause of abortion, 365
Malarial fever simulating puerperal infection, 635
Malformations of new-born child, 652
Malnutrition in fœtus, 356
Malpighian bodies, development of, 110
Malposition of head, 483
Malpositions in placenta prævia, 542
in twin births, 515
with prolapsus funis, 520
Malpresentation in placenta prævia, 542
with prolapsus funis, 520
Malrotation of head in breech cases, 501
Mammary abscess, 273
glands, accessory glands of, 66
acini of, 67
anatomy of, 63
changes of, in pregnancy, 65

Mammary glands, hygiene of, during pregnancy, 159
lobes of, 65
lymphatics of, 69
nerves of, 70
nipples of, 63
signs of pregnancy in, 133
vessels of, 68
infection, source of, 593
signs of pregnancy. *See* Pregnancy, diagnosis of.
Management of labor, first stage, 244
second stage, 247
third stage, 254
of new-born child, 283
of pregnancy, 157
Manual dilation in eclampsia, 574
in placenta prævia, 546
extraction in pelvic presentations, 499
Massage in birth paralyses, 658
mammary, 594
Mastitis, 592
etiology of, 273, 592
forms of, 594
in new-born child, 664
treatment of, 664
suppuration in, 595
symptoms of, 593
treatment of, 594
prophylactic, 594
Masturbation, changes in breast from, 135
Mauriceau method of manual extraction, 499
Maxilla, inferior, development of, 105
fracture of, at birth, 656
Maxillary process, 105
Meatus urinarius, anatomy of, 21
Mechanical elements of labor, 161
Mechanism, anomalies of, 429
Meconium, 308
in diagnosis of breech cases, 492
Medulla oblongata, development of, 99
Medullary canal, 80
groove, 80
plate, 80
Melancholia, puerperal, 600
Melœna neonatorum, 667
Membrana granulosa of Graafian follicle, 52, 72
propria, 72
Membrane, pseudo-diphtheritic, in puerperal vaginitis, 614
Membranes, adhesion of, 215, 508
caution in delivery of, 700
conditions of, for application of forceps, 707
detachment of, 215
early rupture of, 202
examination of, 255
in premature labor, 699
in face presentations, 489
in multiple pregnancy, 316
pouching of, cause of dystocia, 509
premature rupture of, a cause of prolapsus funis, 520
rupture of, 207, 248
Membranes, rupture of, during labor, 248
in accidental hemorrhage, 550
in partial detachment of placenta, 543
in uterine inertia, 436
separation of, in induction of labor, 698
uterine, development of, 82
with twins, 316
Meningeal apoplexy in new-born child, 658
Meningitis, diagnosis from eclampsia, 562
Meningocele, 652
Menstrual discharge, 71
Menstruation, apparent, during pregnancy, 132
causes of, 71
character of discharge, 71
coincident with ovulation, 73
disturbances of, in ectopic gestation, 395
duration of, 71
in pregnancy, 131
normal, 71
physiology of, 71
return of, after labor, 259
suppression of, diagnostic value, 131
Mental affections in pregnancy, 598
condition, care of, during puerperium, 270
during pregnancy, 160
impressions a cause of onset of labor, 198
rest in puerperium, 270
Mercurial ointment in congenital syphilis, 671
Mercuric chloride as an antiseptic, 239
cyanide as an antiseptic, 239
iodide as an antiseptic, 239
Mesenchyme, 79
Mesentery, development of, 107
Mesoderm, development of, 78
of ovum, 78
tissues developed from, 80
Mesodermic somites, 81
Mesogastrium, 106
Mesorectum, 32
Mesosalpinx, 45
Mesothelium, 79
development of, 110
Metabolism of pregnancy, 126
Metritis, chronic, resembling pregnancy, 151
puerperal, 617
Metrorrhagia, a contraindication to nursing, 287
Milk and cream mixtures, 299
changes in, from sterilization, 296
condensed, 297
cows', dilution of, 298
modifying of, 297
removal of casein from, 303
effect of excess of fat in, 300
of sugar in, 300
"fever," 266, 635
human, abnormal, 288
chemical composition of, 268
composition of, 287

Milk, human, composition of, at different months, 290
daily secretions, 290
difference between human and cows', 293
normal, 288
variations in quantity and composition, 290
table of, 289, 290
vs. cows', 294
hypersecretion of, 594
laboratories, 300
maternal, 287
presence of bacteria in, 593
mechanical modification of, 298
microscopical examination of, 288
modified, 295, 297
Rotch, 299
Pasteurization of, 297
peptonization of, 306
preparation of, Vigier's method, 301
secretion of, in pregnancy, 135
stasis, 592
sterilized, 295
advantages of, 296
Miscarriage (immature labor), 362
definition of, 362, 689
in multiple pregnancy, 317
Mitral valve, lesions of, 585
Mobility of fœtal head, 184
of pelvic joints during labor, 166
Mole, blood, 368
fleshy, 368
vesicular, 324
Monro, foramen of, 98
Mons pubis. *See* Mons veneris.
veneris, anatomy of, 17
development of, 114
Monsters, double, obstructing labor, 518
fœtal, diagnosis of, 488
relation of, to labor, 519
Monstra per defectum, 339
per excessum, 351
per fabricam alienam, 352
Monstrosities in multiple pregnancy, 317
obstructing labor, 518
Montgomery, follicles of, 135
glands of, 65
Monti modification of milk, 301
Morbus cæruleus, causes of, 97
Morgagni, cysts of, 50
Mortality in eclampsia, 565
maternal, in concealed "accidental hemorrhage," 549
in placenta prævia, 541
in podalic version for placenta prævia, 546
in rupture of uterus, 532
Morula of ovum, 77
Mother, examination of, after labor, 257
dangers to, from version, 742
Moulding of fœtal head, 183, 214
excessive, 655
Mouth, development of, 104
Müller, ducts of, 44
Multiple pregnancy, 315
diagnosis of, 318
Multiply pregnancy, vaginal signs in, 318
Mummification of fœtus, 356
in ectopic pregnancy, 405
Murphy binder, 594
Muscles, abdominal, action of, in labor, 162
coccygeus, 40
compressor urethræ, anatomy of, 44
constrictor vaginæ, anatomy of, 34
corrugator cutis ani, 30
erector clitoridis, anatomy of, 34
Guthrie's, 44
injuries to, in new-born child, 656
internal sphincter ani, anatomy of, 31
ischio-bulbosus, 34
ischio-cavernosus, 34
levator ani, anatomy of, 37
obturator internus, anatomy of, 35
relation to parturient canal, 177
plates, development of, 81
pyriformis, anatomy of, 35, 177
relation to parturient canal, 177
sphincter ani externus, anatomy of, 32
internus, anatomy of, 31
vaginæ, anatomy of, 21, 34
transversus perinei, anatomy of, 34
Muscular system, diseases of, in fœtus, 360
Myomata, uterine, with prolapsus funis, 520
Myotomes, development of, 81
Myxoma chorii, 324

N.

Nabothian follicles, 61
Naegele pelvis, 458
Naegele's rule, 155
Nævi, 359
Naphthalin internally, indication for, 604
Nasal passages, development of, 106
pits, 106
process, 106
Nausea and vomiting, diagnostic value of 132
during pregnancy, 422
Navel cord hernia, 330
protrusion of, 136
Neck of new-born child, 278
Neck-bend of embryonic brain, 97
Nephritis, acute, an indication for induction of abortion, 690
Nerves of Fallopian tubes, 57
of mammary gland, 70
of ovaries, 57
of pelvic floor, 54
of pudendum, 54
of uterus, 57
of vagina, 55
Nervous system, brain, neck-bend, 97
primary head-bend, 97
Varolian bend, 98
central, development of, 97
changes in, during pregnancy, 160

Nervous system, diseases of, contraindication to nursing, 287
disorders of, in pregnancy, 425
fore-brain, 97
hind-brain, 97
mid-brain, 97
Neural canal, 80
of new-born child, 278
organs of special sense, 100
primary cerebral vesicles, 97
spinal cord, 99
Neuralgia in pregnancy, 425
New-born child and its management, 277
Nipple, anatomy of, 65
erectility of, 135
shields, use of, with sore nipples, 591
Nipples, anomalies and diseases of, 589
treatment of, 591
care of, 220
during pregnancy, 159, 590
infection from, 592
irritation of, to stimulate uterine contraction, 693
sore, 590
etiology of, 590
treatment of, 590
curative, 591
preventive, 590
Nitrate of silver in fissured nipples, 591
in ophthalmia, 669
Nitrogenous substances, ratios of, in urine of pregnancy toxæmia, 421
Nose, development of, 106
Notochord, 80
Nourishment during puerperium, 269
Nuclein in milk, 294
in treatment of puerperal infection, 651
Nucleolus of ovum, 75
Nucleus of ovum, 74
segmentation of, 77
Nurse, antiseptic precautions for, 242
Nursing-bottles, 306
Nursing, hygiene of, 272
maternal, 285
contraindications to, 287
of infant, contraindications to, 272
time of, 272, 286
of new-born child, 285
painful, relief of, 591
to stimulate uterine contractions, 272
weaning child, 273
wet-, 291
Nutrition, maternal, changes due to pregnancy, 125
weight as a sign of, 307
Nymphæ. *See* Labia minora.

O.

Oatmeal-water in diluting milk, 298
Obesity *vs.* pregnancy, 151
Obstetric anatomy of bony pelvis, 163
examination, objects of, 160
positions, 247
surgery, 677
Obstetrician, armamentarium of, 236
Obstetrician, duties of, during labor, 219
Obturator fascia, 36
foramen, 167
internus, 35
Occipital protuberance, 181
Occiput, 181
Occiput-posterior cases, abnormal forms, 484
diagnosis of, 483
management of, 485
mechanism of labor, 483
Œdema, fœtal, 361
general, of fœtus obstructing labor, 513
in hydramnios, 323
in pregnancy toxæmia, 424
of vulva, cause of dystocia, 480
suprapubic, in plural pregnancy, 318
Œsophagus, development of, 106
Oidium albicans, 672
Olfactory plates, 106
Oligo-hydramnios, 322
cause of abortion, 367
in plural births, 515
relation of, to talipes, 360
Omentum, development of, 107
Omphalo-mesenteric vessels, 92
Oöphoritis, puerperal, 618
Operating gown, 710
suit, 241
Operation for immediate repair of internal vaginal lacerations, 681
of lacerated cervix, 688
Operations, episiotomy, 253
for perineal operations, 681
Ophthalmia neonatorum, 668
treatment of, 669
Opisthotonos in eclampsia, 559
Opium in abortion, 374
in "accidental hemorrhage," 550
in delayed labor, 439
in eclampsia, 568
in threatened abortion, 374
in uterine inertia, 439
Optic cup, primary, 100
secondary, 101
lens, 101
nerves, development of, 98, 102
vesicles, development of, 98
Oral plate, 104
Organic diseases as cause of abortion, 364
Organs, abdominal, enlargement of, resembling pregnancy, 152
of Rosenmüller. *See* Parovarium.
development of, 112
of special sense, development of, 100
Osseous system, changes in, due to pregnancy, 128
diseases of, in fœtus, 360
Osteophytes, puerperal, 128
Ostium abdominale, 49
vaginæ, 21
Otocyst. *See* Auditory vesicle, 103
Outlet, pelvic, diameters of, 172
landmarks of, 167
plane of, 169

Ovarian cystoma, diagnosis from hydramnios, 323
pregnancy, 383
Ovaries, anatomy of, 50
in puerperium, 263
nerves of, 56
vessels of, 56
Ovary, cortical zone of, 52
cystoma of, *vs.* pregnancy, 152
development of, 111
hilum of, 51
tumors of, cause of dystocia, 482
tunica albuginea of, 52
zona vasculosa of, 52
Oviducts. *See* Fallopian tubes.
Ovula of Naboth, 61
Ovulation, physiology of, 72
Ovum, changes in, in ectopic gestation, 390
development of, 73
fertilization of, 73, 76
implantation of, 86
loosening attachment of, in labor, 197
maturation of, 73, 74
nourishment of, 83
zona pellucida of, 74
radiata of, 74
Oxygen in eclampsia, 575
inhalations in pre-eclamptic state, 566
Ozæna a source of infection in puerperium, 621

P.

Pad, perineal, 681
Pain in ectopic gestation, 395, 404
in pregnancy toxæmia, 425
Pains, after-, 217, 264, 271
in uterine inertia, 434
rupture, 531
labor-, 207
weakness of, 434
Pallor in insanity, 601
Palpation of anterior shoulder, 225
of cephalic prominence, 226
of fœtal parts in abdominal examination, 137
of lower fœtal pole, 223
of upper fœtal pole, 224
Palpitation during pregnancy, 426
from heart lesions, 586
Pampiniform plexus, 56
Pancreas, development of, 108
Pander, islands of, 88
Paralysis, central, in new-born child, 658
Duchenne's, diagnosis of, 657
in new-born child, 657
Erb's, 657
facial, in new-born child, 656
Parametritis, puerperal, 617
Parietal protuberance, 181
zone, 81
Paroöphoron, anatomy of, 53
Parovarium, 112
anatomy of, 45, 52
development of, 112
Pars intermedialis, 23
Parsley, ecbolic action of, 691
Passages, maternal, as element of labor, 163
obstructions of, indicating use of forceps, 708
Pasteurization of milk, 297
Pathology of fœtus, 332, 354
of labor, 429
of pregnancy, 315
Patient, disinfection of, preparatory to labor, 640
Pelvic deformities, classification of, 446
measurement of, 442, 444
diameters and measurements, 171
fascia, anatomy of, 35
floor, action of, in labor, 163
anatomy of, 32
blood- and nerve-supply of, 54
fasciæ of, 677
measurements of, 178
muscles of, 32–34
retraction of, in labor, 206
segments of, 177
structure of, 177
organs, care of, during pregnancy, 159
female, anatomy of, 17–70
hygiene of, during pregnancy, 159
peritoneum, changes due to pregnancy, 123
presentation a cause of dystocia, 491
diagnosis of, 492
etiology of, 491
frequency of, 491
general management of, 494
malrotation of head, 501
management of special conditions in, constriction of head by uterus, 498
impaction of breech, 496
of head, 499
non-engagement at brim, 495
upward displacement of arms, 497
mechanism of, 493
abnormalities of, 494
methods of delivery, after embryulcia, 500
forceps extraction, 499
manual extraction, 499
moulding of fœtus in, 494
prognosis of, 493
Pelvigraphy, 446
Pelvimeter, 236
Baudelocque's, 443
Collyer's, 228
Hirst's, 232
Pelvimetry, 442
external, 229
internal, 231, 444
in pelvic deformities, 442
prognosis of, 493
x-ray, 446

Pelvis. *See* Labor.
anchylosis of joints of, 467
anomalies of size, shape, or inclination, 450
antero-posterior diameters of, 442
articulations of, during pregnancy, 125
bony, development of, 114
brim of, 166
plane of, 169
cavity of, true, 167
changes due to pregnancy, 125
circumference of, external, 174
compressed (malacosteon), 461
diagnosis of, 461
etiology of, 461
influence of, on labor, 462
pseudo-malacosteon, 462
treatment of, 462
constituent parts of, 164
contracted, forceps in, 708
obliquely (Naegele pelvis), 458
etiology and diagnosis of, 459
from imperfect use of one limb, 459
from lateral curvature of spine, 460
transversely (Robert pelvis), 460
from kyphosis of spine, 461
deep, 450
deformities of, 440
æquabiliter-justo-major, 447
justo-minor, 448
causes of, in early life, 442
classification of, 446
diagnosis of, 442
distorted by anchylosis of, 467
by double dislocation backward of femora, 465
by fracture of pelvis, 467
by injuries, disease, or tumors, 465
by tumors, 465
due to spinal curvature, 467
dwarf form, 448
flat, non-rachitic, etiology and diagnosis of, 451
rachitic, 452
breech delivery in, 455
diagnosis of, 454
etiology of, 453
treatment of, 456
simple, 451
frequency of, 441
from osteomalacia, 442
from rachitis, 442
from tuberculosis, 442
funnel-shaped, 450
infantile, 448
in relation to post-partum state, 471
justo-minor, etiology of, 448
treatment of labor in, 450
kyphoscoliotic, 470
kyphotic, 467
diagnosis of, 468
Pelvis, deformities of, lordosis of, 470
masculine, 450
most-frequent varieties, 441
Naegele, 452, 458
obliquely contracted, 458
imperfect development of one sacral ala, 458
diagnosis of, 504
etiology of, 459
influence on labor, 459
treatment of, 459
use of one limb, 459
lateral curvature of spine in, 460
pseudo-malacosteon, 454
pseudo-rachitic, 462
rachitic, generally contracted, 453
infantile, 453
rostrate, 454
treatment of labor in, 456
Robert, 460
scoliotic, 469
shallow, 450
split, 467
spondylolisthetic, 463
etiology and diagnosis of, 464
transversely contracted imperfect development of both sacral alæ, 460
kyphosis, 461
uniformly contracted, 448
enlarged, 447
development of, 114
diameter of, diagonal conjugate, 445
external, in deformities, antero-posterior, 442
internal, 171
in deformity, transverse, 444
transverse, 171, 444
true conjugate, 171
doubly obliquely contracted, 460
dwarf, 448
dynamic, 173
measurements, external, 173
internal, 173
examination of, in pregnancy, 172
false, 166
fractures of, 467
Hirst's measurement of, 445
inclination of, 170
inferior strait. *See* Outlet.
inlet. *See* Brim.
isthmus. *See* Brim.
landmarks at brim, 166
at outlet, 167
Löhlein's measurement of, 445
male *vs.* female, 176
measurements of, 174
external, in deformed pelves, 442

Pelvis, measurements of, external, in deformities, oblique, 444
internal, 171
diagonal conjugete, 445
of Hirst, 445
of Löhlein, 445
middle plane of, 169
minor developmental peculiarities of, 450
muscles of, 177
oblique diameters of, 444
obstetric anatomy of, 163
planes of, 168
outlet of, 166
plane of, 169
parturient axis of, 178
racial differences in, 176
renal, development of, 110
shape of pelvic canal, 173
soft parts of, 176
static measurements, brim, 171
middle plane, 172
outlet, 172
true, 166
cavity of, 167
margin of, 166
Pemphigus neonatorum, 670
Penis, development of, 114
Pennyroyal, ecbolic action of, 691
Peptonized milk, 306
Perchloride of iron in post-partum hemorrhage, 555
Perforation, indications for, 750
Pericardial effusion, fœtal, 513
Perineal body, anatomy of, 41
ledge, anatomy of, 34
space, anatomy of, 34
boundaries of, 17
stage of labor, 251
Perineum, anatomy of, 18
development of, 112
effect of extensive rupture of, 599
immediate repair of, 684
lacerations of, 685
in precipitate labor, 432
prevention of, 251
Peritoneum, pelvic, 123
Peritonitis, 633
in ectopic gestation, 404
puerperal, 618
Perivitelline space, 74
Peroxide of hydrogen as an antiseptic, 239
Pflüger, cords of, 112
Phantom tumor *vs.* pregnancy, 153
Pharynx, development of, 105
Phlebitis, puerperal, 615
Phlegmasia alba dolens, 619
in puerperal infection, 634
Physiology of labor, 161
of ovulation, 72
of pregnancy, 71, 160
Physometra, 381
Pigmentation of abdomen in pregnancy, 137
of breasts, 133
of nipples and abdomen, 267
Pigmented layer, 101
Piles, external, 30
internal, 32
Pilocarpine in eclampsia, 573
in inducing labor, 691
Pinard's rule, 508
Placenta, accessory, 329
adherent, 699
causes of, 700
treatment of, 702
after abortion, 371
anomalies of, 327
of shape, 327
of size, 327
battledore, 327
calcareous degeneration of, 330
changes of, in tubal pregnancy, 392
circumvallate, 329
complete separation of, in placenta prævia, 547
cotyledons of, 88
cysts of, 329
detachment of, 215
in placenta prævia, 547
diseases of, 327
examination of, 255
in premature labor, 699
expression of, 254
expulsion of, Credé's method of, 254
in labor, 215
method of, 215, 642
in twin birth, 319
formation of, 87
horseshoe shape, 539
infarcts of, frequency and pathology of, 329
in multiple pregnancy, 316
layers of, 88
location of, 229
from external signs, 139
manual extraction of, 255
marginata, 329
membranacea, 327
multiple, 327
partial separation of, in placenta prævia, 547
prævia, 538
as cause of abortion, 367
diagnosis of, 541
etiology and symptoms of, 540
examination of, by vagina, 541
frequency of, 539
hemorrhage from, etiology of, 540
post-partum, 552
instruments used in cases of, 544
rupture of membranes in partial detachment of, 544
structural anomalies of, 539
symptoms of, 540
treatment of, 542
after the fœtus is viable, 542
before the seventh month, 542
varieties of, 539

Placenta, primitive bloodvessels of, 89
retained, 699
causes of, 700
secondary hemorrhage from, 557
treatment of, 700
shape of, 327
size of, 327
spuria, 327
structure of, 88
succenturiate, 328
syphilis of, 328
treatment of, in Cæsarean section, 767
in rupture of uterus, 533
tuberculosis of, 328
tumors of, 329
white infarctions of, 328
with twins, 316
Placentæ in triplet births, 518
spuriæ, 328
succenturiatæ, 316, 328
Placental apoplexy as cause of abortion, 367
separation, mechanism of, 700
Placentitis, 328
adherent placenta from, 700
Planes of fœtal head, 183
of pelvis, brim, 169
middle, 169
outlet, 169
Pleura, development of, 108
Pleural sacs, development of, 108
Plexuses, nerve, inferior hypogastric, 56
ovarian, 57
venous, of ovaries, 57
of vagina, 55
pampiniform, 57
Plica gubernatrix, 45
transversalis recti, 31
Plicæ palmatæ, 59
Plural births cause of dystocia, 514
Pneumococcus in puerperal infection, 609
Pneumonia, fœtal, 359
Polar globule, 75
Polygalactia, 597
Polyhydramnios, 322
as cause of abortion, 367
Polypi, decidual, 368
Polypus of uterus cause of dystocia, 479
diagnosis from inversion, 526
placental, after abortion, 368
Pomeroy bag, 544
Pons Varolii, development of, 99
Porro-Cæsarean operation, 770
advantages of, 770
for carcinoma of cervix with pregnancy, 479
indications for, 770
in malacosteon pelvis, 462
technique of, 770
section, indications for, 770
technique of operation, 770
Position of child, definition of, 185
determination of, from fœtal heart-sounds, 142
diagnosis of, 213
mento-anterior, indication for forceps in, 708
Position of child, occipito-posterior, indication for forceps in, 708
relative frequency of, 186
varieties of, 186
of presenting part, determination of, 185, 186
Posterior commissure, 18
Post-partum hemorrhage, 551
secondary, causes and treatment of, 557
Posture, definition of, 186
for prolapse of cord, 522
obstetric, during labor, 247
of fœtus, 186
of patient in forceps operation, 711
Pouch, vesico-uterine, 43
Præputium, anatomy of, 19
Prague grasp in pelvic presentation, 499
Precipitate labor, 431
Pre-eclamptic state, 559
treatment of, 565
Pregnancy, abdominal, 383
signs of, 136
without rupture, 400
affected with justo-major pelvis, 447
changes in maternal organs caused by, 118
cornual, 385, 417
diagnosis of, 131
abdominal signs of, 136
auscultation, 139
heart, fœtal, 139
maternal, 139
murmur, umbilical, 142
uterine, 142
shock, fœtal, 143
inspection, contour, 136
palpation, 137
ballottement, 138
contractions, 138
fœtal movements, 138
parts, 137
size of fundus, 137
percussion, 139
pigmentation, 137
striation, 137
value of, 137
summary of, 136
differential, history of, 131
in early months, 151
in later months, 151
mammary signs in, 133
breast enlargement, 133
milk secretion, 135
pigmentation, 133
primary areola, 133
secondary areola, 135
summary of, 133
value of, 135
veins of, 133
nausea and vomiting, 132
order of examination, 136

Pregnancy, differential, pelvic signs, 143
early change in uterus, 145
intermittent contractions, 146
method of examination of, 143
purplish hue of cervix, 144
of vagina, 144
preparation for examination, 136
quickening in, 133
salivation in, 133
signs by months in, 150
suppression of menses in, 131
diseases of, 418
albuminuria, 420
causes of, 420
toxæmia, 418
changes in urine in, 420
eye symptoms in, 424
etiology of, 418
jaundice in, 424
nature of poisons in, 418
œdema in, 424
pain in, 425
pathological anatomy of, 420
prophylaxis of, 425
ptyalism in, 424
skin manisfestations in, 425
stomatitis in, 424
treatment of, 425
vomiting in, 422
disorders of, circulation, 426
dyspnœa, 426
hemorrhoids, 426
palpitation, 426
syncope, 426
varicose veins, 426
duration of, 154
early abortion in, 363
extra-uterine. *See* Ectopic gestation.
general changes during, 125
hygiene of, 157
bathing, 158
clothing, 158
coitus, 159
diet, 157
digestive organs, 158
examination during, 160
exercise, 158
mammary glands, 159
mental condition, 160
nervous system, 160
pelvic organs, 159
personal observation, 157
rest, 158
urine, 159
infundibular, 383
in patients not menstruating, 132
interstitial, 383
management of, 157
multiple, 315
diagnosis of, 318
frequency of, 315
Pregnancy, multiple, management of labor in, 318
mode of origin of, 316
pathology of, 317
post-partum hemorrhage from, 552
sex of twins, 316
ovarian, 383
pathology of, 315
pelvic signs of, 143
physiology of, 71–160
plural, heart-sounds in, 142
recent, signs of, 275
signs of, tabulated by months, 150
spurious, diagnosis of, 153
toxæmia of, 418
tubal, 386
rupture of, diagnosis from accidental hemorrhage, 549
unruptured, 400
twin, diagnosis, 318
value of mammary signs in, 135
Premature infants, care of, 309
labor, definition of, 362, 689
Preparations for labor, 243
Prepuce, development of, 114
Presentation, breech, prolapse of limbs in, 507
brow, 490
definition of, 184
determination of, from fœtal heart-sounds, 142
diagnosis of, 221
face, diagnosis and prognosis of, 487
etiology of, 486
head, prolapse of limbs in, 507
longitudinal, 184
pelvic, abnormalities in mechanism of, 494
diagnosis of, 492
frequency of, 491
management of special conditions in, 495
relative frequency of, 185
transverse, 185, 501
decapitation in, 758
diagnosis of, 502
podalic version in, 729
positions in, 502
prolapse of limbs in, 507
spontaneous delivery in, 503
varieties of, 501
version in, 739
varieties of, 181
vertex, recognition of, 246
Presentations in twin births, 515
relative frequency of different, 185
Presenting part, 185
Primæ viæ, lesions of, in fœtus, 359
Primary intraperitoneal rupture in ectopic pregnancy, 396
Primipara, eclampsia in, 562
Primitive bloodvessels, 89
chorion, 83
embryonic circulation, 92
streak, 80
Proamnion, 79

Processus globulari, 106
Prochownick diet to prevent dystocia, 473
Prolapse of limbs, 507
in breech presentation, 507
in head presentation, 507
in transverse presentation, 507
Prolapsus funis, diagnosis and prognosis of, 521
frequency and etiology of, 521
indication for use of forceps in, 708
treatment of, 522
uteri, 477
Pronucleus, female, of ovum, 76
male, of ovum, 76
Protargol in ophthalmia, 669
Protuberances of fœtal skull, 181
Pseudo-hermaphrodites, female type, 347
male type, 346
Psychical disorders from forceps operation, 709
influence in puerperal insanity, 598
Ptyalism in pregnancy, 424
Pubo-coccygeus, 39
rectalis, 39
Pudendum, anatomy of, 17
vessels and nerves of, 20
Puerperal fever, epidemics of, 620
infection, 605
air as a source of, 621
auto-infection in, 622
bacteriology of, 605
curative treatment of, 643
diagnosis of, 634
endometritis in, 614
etiology of, 620
external modes of, 621
frequency of, 630
lesions of vulva and vagina in, 614
modes of external, 621
mortality from, 630
organisms causing, 605
pathological anatomy of, 613
symptomatology of, 631
treatment of, 639
insanity, prognosis of, 602
symptoms of, 599
treatment of, 602
state, definition of, 259
diagnosis of, 275
positive signs of, 275
probable signs of, 276
uncertain signs of, 276
sweats, 267
ulcer, 614
vaginitis, 614
woman, care of, 269
Puerperium, after-pains of, 264
bowels in, 265
care of genitalia in, 271
of patient in, 269
condition of outlet and vagina, 260
danger of infection in, 260
diagnosis of, 275
final examination, 275
Puerperium lactation, 267
pathology of, 589
physiology of, 259
pulse in, 266
temperature in, 265
urine in, 265
uterine involution in, 261
visits of physician, 274
Pulmonary congestion in pregnancy from cardiac disease, 586
organs, development of, 108
Pulse after labor, 266
chart, 235
during puerperium, 266
fœtal, during labor, 207
in acute anæmia, 541
maternal, in labor, 207
with post-partum hemorrhage, 552
Pupil, development of, 101
Purgation to induce abortion, 692
Purkinje, vesicle of, 74
Putrefaction, intestinal absorption of products of, as a cause of puerperal insanity, 599
of fœtus, 356
Pyæmia, 618
symptoms of, in puerperal infection, 633
Pyosalpinx, 633
Pyriformis muscle, 36, 177

Q.

Quickening, appearance of, 116
diagnostic value of, 133
reckoning date of labor from, 155
Quinine as cause of abortion, 365
ecbolic action of, 691
in abortion, 691
in delayed labor, 436

R.

Rauber's layer, 77
Recession of fœtal head between pains, 213
Recessus labyrinthi, 103
Rectal injections of salt solution, 556
Recto-vaginal pouch, 32
septum, 29
Recto-vesical fascia, 36, 40
pouch, anatomy of, 30
Rectum, ampulla of, 31
anatomy of, 30, 177
carcinoma of, cause of dystocia, 481
distension of, obstructing labor, 481
impacted, a cause of retained placenta, 700
malformation of, congenital, in newborn child, 655
relation of, to parturient canal, 177
structure of, 30
Respiration, artificial, in asphyxia of newborn child, 660
Byrd's method, 661
direct insufflation, 660
Laborde's method, 662
Schultze's method, 661

Respiration, changes in, during pregnancy, 126
following labor, 267
in early infancy, 279
of new-born child, 279, 283
Respiratory organs, maternal, changes due to pregnancy, 126
Rest during pregnancy, 158
during puerperium, 269
Restitution of fœtal head, 213
Rete testis, development of, 111
Retina, development of, 101
Retraction of pubic segment of pelvic floor, 206
of uterus, 218, 255
Retrodisplacement in post-partum hemorrhage, 558
Retroflexion of uterus resembling pregnancy, 151
Rheumatism, chronic, contraindication to nursing, 287
Rickets, effect of, on pelvis, 452
pelvic deformities associated with, 442
Ring of Bandl, 204
Rings, cervical, 206
Robert pelvis, 460
Room, lying-in, 271
Rosenmüller, organ of, 112
Rotation, complete, in transverse presentation, 503
external, of fœtal head, 213
of head in labor, 210
Rotch cream mixtures, 300
Round ligament, anatomy of, 18, 53
Rowbotham diet to prevent dystocia, 473
Rue, ecbolic action of, 691
Rugæ vaginæ, 28
Rupture, primary intraperitoneal, in ectopic pregnancy, 396
extraperitoneal, in ectopic pregnancy, 390
of symphysis pubis, 534
of uterus, 528
Ruptures, secondary, in ectopic pregnancy, 399

S.

Saccharomyces albicans, 672
Sacculus, development of, 103
Sacrum, promontory of, 166
Saline infusion in eclampsia, 573
in puerperal infection, 646
Salivation, diagnostic value of, 133
Salpingitis, puerperal, 618
Salt solution, 556
Sapræmia a cause of puerperal insanity, 599
infection, 612
Savine a cause of abortion, 365
Schneiderian membrane, development of, 106
Sclera, development of, 101
Sclerema neonatorum, 670
Scrotum, development of, 114
Sea voyages, effect of, on menstruation, 132
Secondary embryonic circulation, 92
Secretion, vaginal, in labor, 207
Secundines, retained, post-partum hemorrhage from, 552, 557
Segmental zone, 81
Segmentation cavity of ovum, 77
nucleus of ovum, 77
Semicircular canals, development of, 103
Seminiferous tubules, 111
Senses, special, of new-born child, 278
Sepsis, bacillary, 611
following abortion, treatment of, 377
in abortion, 364
treatment of, 377
in ectopic gestation, 405
in new-born child from umbilical infection, 667
puerperal, treatment of, 643
Septa, urethro-vaginal, 44
Septic cases of ectopic pregnancy, vaginal incision in, 409
infection a cause of puerperal insanity, 599
Septum, inferior, in embryonic circulation, 92
recto-vaginal, 29
superior, in embryonic circulation, 92
urethro-vaginal, 29, 43
vesico-vaginal, 29
Serum, anti-streptococcus, in puerperal infection, 648
Sewer-gas, infection from, 622
Sex of fœtus, determination of, by heart-sounds, 139
Sexual gland, 111
organs, development of, 44, 111
Shock, fœtal, in diagnosis, 143
Shoulder, anterior, location of, 225
delivery of, in normal labor, 214
presentation of, 504
Show, 207
Signs of beginning labor, 244
of pregnancy. *See* Pregnancy, diagnosis of.
in diagnosis, Hegar's, 145
Jacquemin's, 144
Jewett's, 144
Silkworm-gut suture in vaginal repairs, 681
Sinciput, 181
Sinus rhomboidalis, 80
terminalis of placenta, 89
uro-genital, 112
venosus, 92, 95
Situs transversus, 359
Skeleton, development of, 114
Skin, changes in, due to pregnancy, 127
diseases of, in fœtus, 361
following labor, 267
manifestations in pregnancy toxæmia, 425
of new-born child, 282
pigmentation of, during pregnancy, 133
Skull, unduly ossified, cause of dystocia, 508
Smegma, secretion of, 19

Smellie grasp in pelvic presentations, 499
-Veit method of manual extraction, 499
Softening of cervix in pregnancy, 148
Solutions, antiseptic, 239
Somatopleure, development of, 81
Souffle, funic, in diagnosis, 142
placental, in ectopic gestation, 402
uterine, in diagnosis, 142
Special senses in new-born child, 278
Spermatozoön, fertilization of ovum by, 76
Sphincter ani, external, 32
internal, 31
repair of rupture of, 685
retraction of torn ends of, 685
rupture of, 684
tertius, 31
vaginæ, 21
vesicæ, 41, 43
Spina bifida, 653
accompanying hydrocephalus, 511
cause of dystocia, 511
treatment of, 653
Spinal canal at first month, 115
column of new-born child, 278
cord, cauda equina of, 100
columns of, 99
development of, 99
filum terminale of, 99
fissures of, 99
injuries to, at birth, 656
neural canal of, 99
Splanchnopleure, development of, 81
Spleen, anomalous position of, 353
during pregnancy, 126
fœtal, lesions of, 359
in pregnancy toxæmia, 420
Spondylolysis in transverse presentation, 507
Spondylotomy in transverse presentation, 507
"Spontaneous evolution," 504
rare variety of, 504
rupture of uterus, 530
version, 503
Sprue. *See* Thrush.
Stages of labor, 195
of uterine contractions, 161
Staphylococcus in puerperal infection, 607
Steam sterilization, 238
Stenosis, anal and rectal, 655
Sterility, diabetes a cause of, 584
Sterilizer, Arnold, 238
Sterno-cleido-mastoid, hæmatoma of, at birth, 656
Stethoscope in abdominal examination, 142
Stigma, 52, 73
Still-born infants, 663
Stimulants in post-partum hemorrhage, 554
Stomach, anomalous development of, 353
development of, 106
infantile, capacity of, 306
of new-born child, 280
Stomatitis in pregnancy toxæmia, 424
Strait, inferior, 166
superior, 166
Streptococcus erysipelatus, 621
in puerperal infection, 621
pyogenes in puerperal infection, 606
Striation of abdomen in pregnancy, 137
Strychnine in puerperal infection, 646
Styptics in post-partum hemorrhage, 554
Subclavian artery, origin of, 93
Subcutaneous injections of salt solution, 556
Submammary bursæ, 66
Sugar, human, *vs.* cows' milk, 294
in milk, effect of sterilization upon, 296
in urine following labor, 265
Sulphonal in puerperal insanity, 604
Superfecundation, 317
Superfœtation, 317
Superficial perineal fascia, 34
Superior strait, 166
Supernumerary nipples, 589
Suppression of menses, diagnostic value of, 131
Suprarenal capsule, development of, 110
Suture of uterus in Cæsarean section, 768
silkworm, use of, 686
Sutures, buried catgut, use of, 685
of fœtal head, 179
coronal, 179
lambdoidal, 179
sagittal, 179
Sylvius, aqueduct of, 98
Symphysiotomy, 772
after-treatment of, 782
Ayre's hammock bed in, 782
closure of wound in, 781
contraindication to, 774
defined, 772
history of, 772
indication for, 773
in connection with craniotomy, 751
in flat pelvis, 458
in tumors of pelvis, 466
methods of rest following, 782
mortality of, 773
objections to, 773, 774
present status of the operation, 773
rationale of the operation, 774
technique of the operation, 774
value of, compared with forceps and version, 749
with contracted pelvis, 450
with flat pelvis, 457
Symphysis pubis, 165
rupture of, 534
causes and diagnosis of, 535
prognosis and treatment of, 535
Synclitism, 209
Syncope, 541
in pregnancy, 426
Syphilis, adherent placenta from, 700
congenital, a cause of icterus, 666
Colles' law, 671
treatment of, 672
in fœtus, 359

Syphilis in new-born, 670
of decidua as cause of abortion, 364, 367
of placenta, 328

T.

Table, human and cows' milk compared, 294
Tachycardia, fœtal, 358
Talipes, centric, 360
Tampon, cervical, in placenta prævia, 544
in abortion, 376
of uterus in post-partum hemorrhage, 555
vaginal, for induction of premature labor, 699
in inducing abortion, 693
in placenta prævia, 543
to induce abortion, 693
Tansy, ecbolic action of, 691
Tarnier's incubator, 312
Taxis in repositing inverted uterus, 527
Teeth, caries of, during pregnancy, 129
Temperature after labor, 265
causes of rises of, in puerperium, 633
chart, 235
during puerperium, 265
of new-born child, 280
Temporal fontanelle, 180
Tents or dilation of cervical canal, 699
Testis, development of, 111
time of descent of, 117
Tetanus neonatorum, 669
treatment of, 669
uteri, 437
diagnosis, 438
prognosis and treatment of, 438, 439
Thoracic duct, development of, 97
Thorax of new-born child, 278
Thrombi, dislodged, in post-partum hemorrhage, 558
Thrombosis following abortion, 696
of vagina and vulva, 535
etiology and symptoms of, 536
treatment of, 536
Thrush, 671
symptoms and treatment of, 672
Thymus gland, development of, 105
Thyroid gland, development of, 105
during pregnancy, 127
Thyro-hyoid bone, development of, 105
Tongue, development of, 106
Tonsils, development of, 105
Torticollis in breech delivery, 493
Toxæmia of pregnancy, 418
changes in urine in, 420
acetonuria, 421
casts, 421
indicanuria, 421
ratios of nitrogenous substances, 421
clinical manifestations of, 422
eye symptoms in, 424
gingivitis in, 424
Toxæmia of pregnancy, jaundice in, 424
nature of, 418
œdema in, 424
pain in, 425
pathological anatomy of, 420
ptyalism in, 424
skin manifestations in, 425
spleen and other organs in, 420
stomatitis in, 424
theories of cause of, 419
theory of, in puerperal eclampsia, 560
toxic origin of, 418
treatment of, 425
dietetic, 425
eliminative, 426
in seven cases, 426
of toxic state, 425
prophylactic, 425
vomiting in, 422
mild type, 422
pernicious type, 423
Trachea, development of, 108
Tragus, development of, 104
Transfusion in post-partum hemorrhage, 556
Transverse positions, 186
presentation, 185, 501
causes of, 501
diagnosis of, 502
dorso-anterior position, 502
frequency of, 501
management of, 505
methods of spontaneous delivery, spontaneous evolution, 504
version, 503
operative procedures, 505
positions, 502
prognosis of, 503
varieties of, 501
Transvêrsus perinei muscles, 34
Traumatism as cause of abortion, 364
detachment of placenta from, 549
Trendelenburg posture in performing version, 741
in reposition of cord, 522
Triangular ligaments, anatomy of, 35, 37
Triple monsters, 352
Triplets, 517
management of labor, 318
Trophoblast, 78
Trophoderm of Minot, 86
Truncus arteriosus, 92
Trunk of fœtus, 184
delivery of, 213
management of birth of, 253
of new-born child, 278
Tubal pregnancy, 383
unruptured, 400
Tube, Fallopian, changes in ectopic gestation, 390
conditions of, causing ectopic gestation, 390
hemorrhages in, in ectopic gestation, 392

Tube, Fallopian, low insertion of, a cause of placenta prævia, 540
Tubercular infection in new-born child, 670
Tuberculosis as a cause of pelvic deformity, 442
cause of abortion, 364
fœtal, 359
in new-born child, 670
maternal, contraindication to nursing, 287
of the placenta, 328
Tubes in puerperium, 263
Tubules of Wolff, 110
Tubuli lactiferi, 67
Tumors affecting pelvis, 465
fœtal, obstructing labor, 514
of placenta, 329
solid, of vagina or vulva, as cause of dystocia, 481
ovarian, obstructing labor, 482
resembling pregnancy, 152
Tunica fibrosa, 73
propria, 73
Twins, 514
arrangement of membranes, 316
complex cases of, 515
head and breech presenting, treatment of, 516
in ectopic gestation, 415
interlocking, 515
treatment of, 516
locked, decollation in, 760
management of labor, 318, 515
mode of origin of, 316
placenta in, 316
pregnancy, dyspnœa from, 126
prognosis in, 515
with prolapsus funis, 520
relation of, to labor, 514
sex of, 316
Tympanic cavity, 103
Tympanites *vs.* pregnancy, 151
Tympanum, development of, 103
Typhoid fever in puerperium, 635

U.

Ulcers, puerperal, 614
Umbilical cord, development of, 89
formation of, 87
hernia, congenital, 654, 665
hemorrhage, 664
infection, 667
vegetations, 664
Umbilicus, infection of, in new-born child, 667
vegetations of, in child, 664
Unguentum, Credé, in mastitis, 595
Unruptured tubal pregnancy, 400
Urachus, development of, 110
Urea, Bartley's test for, 220
estimation of, during pregnancy, 159
excretion of, in pregnancy, 563
importance of testing for, 219
Ureters, course of, 56
Ureters, development of, 110
during pregnancy, 126
Urethra, anatomy of, 43
development of, 114
Urethro-vaginal septum, 29, 43
Urinary solids, 219
system, changes due to pregnancy, 125, 126
in new-born child, 281
tubules, development of, 110
Urine, changes in, after labor, 265
in pregnancy toxæmia, 420
condition of, in eclampsia, 560
during pregnancy, 127, 159
examination of, 219
before operation, 765
during pregnancy, 219
in pregnancy, 564
in puerperium, 265
of new-born child, 282
solids in, estimation of, 219
suppression of, in puerperal eclampsia, 561
Urogenital sinus, formation of, 44, 112
system, development of, 108
Ustilago maidis, 691
Uterine adnexa during pregnancy, 124
contractions, causes of, 196
changes in uterus during, 162
effect of, on placenta, 699
excessive, treatment of, 432
hour-glass, 702
in labor, 161
intermittent, 161, 198
involuntary, 161, 198
methods of promoting, 691
peristaltic character of, 161, 198
stages of, 161
stimulation of, 554
strength of, 162
discharge, examination of, in ectopic gestation, 403
gestation, concurrent with ectopic, 415
incision in Cæsarean section, closure of, 768
membranes, development of, 83
mucosa during puerperium, 263
souffle, 142
Utero-abdominal gestation, 417
-placental circulation, 89
-sacral ligaments, 30, 63
-vaginal canal, development of, 112
plexuses, 55
Uterus, action of segments of, in labor, 200
anatomy of, 57, 176
anteflexion of, resembling pregnancy, 148
arbor vitæ of, 59
as a part of parturient canal, 176
atony of, 326
atresia of cervix, cause of dystocia, 474
bicornis, cause of dystocia, 474
blood supply of, 55
body of, 57
bulging of body of, in pregnancy, 145

Uterus, carcinoma of, cause of dystocia, 479
cervix of, 57
changes in, caused by pregnancy, 86, 145
cervix, 123
position, 119
properties, 120
shape, 118
size, 118
structure, 120
during menstruation, 71
ectopic gestation, 388
following fecundation of ovum, 86
labor, 261
from child-bearing, 59
in labor, 162, 205
properties of, during pregnancy, 120
shape and size in contraction, 162
compressibility of lower segment of, 145
contraction of, following Cæsarean section, 768
during labor, 161
cornua of, 57
date of appearance of signs of pregnancy, 148
density, variations of, 147
development of, 112
developmental anomalies as causes of dystocia, 474
dilation of, in fœtus, 513
disinfection of, after abortion, 378
displacement of, a cause of abortion, 365
during puerperium, 262, 275
distension of, a cause of onset of labor, 197
duplex, 347
early changes of, in diagnosis, 145
elasticity of, in pregnancy, 147
emphysema of, 509
examination of, after Cæsarean section, 769
fallacies in examination of, 148
fibroma of, *vs.* pregnancy, 152
fixation of, a cause of abortion, 365
form of, 118
fundus of, 57
furrows or folds of, 147
growths of, a cause of rupture, 530
hæmatometra of, *vs.* pregnancy, 153
hyperæmia of, resembling pregnancy, 148
increase in size of, during pregnancy, 147
indication for removal of, 770
inertia of, 433
causes of, 433
diagnosis and prognosis of, 435
in post-partum hemorrhage, 551
symptoms of, 434
treatment of, 435
injuries to, in forceps operation, 709
Uterus, intermittent contractions of, in pregnancy, 146
inversion of, 523
degrees of, 524
diagnosis of, 526
etiology of, 524
prognosis of, 526
secondary hemorrhage from, 558
symptoms of, 526
treatment of, 526
prophylaxis, 526
reposition, 527
varieties of, 524
inverted, reposition of, 527
involution of, 262
after abortion, 371
in ectopic gestation, 389
irritable, in labor, 437
isthmus of, 57
laceration of lower segment of, in rapid delivery, 570
latero-version of, 477
ligaments of, 61
longitudinal fibres of, in labor, 204
lower segment of, after labor, 218
in transverse presentation, 503
lymph-spaces of, 58
malpositions of, causes of dystocia, 476
masculinus, 111
massage of, in post-partum hemorrhage, 554
measurements of, at different periods of pregnancy, 118
mensuration of, in determining date of labor, 155
method of making cultures from, 637
of removal in Porro operation, 770
micro-organisms of, 624
motor centres of, 161, 196
muscle-cells of, 262
muscular structure of, 59
tissue of, 57
nerves of, 56, 252
new growths of, 477
normal measurements of, 57
os externum of, 58
internum of, 58
palpation of fundus of, in diagnosis, 137
perforation of, in curettage, 380
peritoneal covering of, 218
position of, 46
during pregnancy, 119
prolapse of, dystocia, 477
retraction of, after labor, 218; 255
in labor, 200
retroflexion of, an indication for induction of abortion, 690
retroversion of, in abortion, 373
resembling pregnancy, 148
rigidity of os and cervix in labor, 437
round ligament of, anatomy of, 18
rupture of, 528
before second stage of labor, 529

Uterus, rupture of, complete, 528
danger of, in placenta prævia, 571
diagnosis of, 531
etiology of, 529
exciting causes of, 530
frequency of, 528
incomplete, 528
indications for forceps in, 708
in hydrocephalus of fœtus, 512
in rapid delivery, 571
in spasmodic contraction, 437
in transverse presentation, 503
pathological anatomy of, 528
predisposing causes of, 529
prognosis of, 532
spontaneous, 528
symptoms of, 531
traumatic, 528
treatment of, 533
operative, 533
complete rupture, 534
incomplete rupture, 523
cœliotomy, 533
drainage, 533
prophylaxis, 533
sacculation of, cause of dystocia, 477
segments of, 176, 199
action of, causing rupture, 531
in rupture, 528
shape of, 118
in transverse presentation, 502
situation of, after labor, 218
size of, 118
in pregnancy, 147
softening of cervix in pregnancy, 148
sound measurements of, during puerperium, 262
spasm and irregularity of, in labor, 437
spasmodic contraction of, 437
strength of contractions of, 162
structure of, 120
subinvolution of, after abortion, 372
resembling pregnancy, 148
table of comparative measurements of multiparous and parous, 261
tardy involution of, 274
unicornis cause of dystocia, 474
vessels of, 55
and nerves of, changes during labor, 263
with fibromyoma, cause of dystocia, 477
Utriculus, 103

V.

Vagina, after-treatment in operation for deep tears of, 687
anatomy of, 26
blood- and nerve-supply of, 54
bulbs of, anatomy of, 25
changes in, due to pregnancy, 125
cysts of, obstructing labor, 481
deep tear of, method of operating, 685
development of, 112
duplex, 347
Vagina during puerperium, 260
fornices of, 27
hæmatoma of, cause of dystocia, 480
treatment of, 537
injuries to, in forceps operation, 709
introitus or ostium of, 21
lacerations of walls of, 260
length of, 27
lymphatics of, 55
micro-organisms of, 625
purplish hue of, in pregnancy, 144
shortening of, resembling prolapsus uteri, 30
stenosis of, cause of dystocia, 480
structure of walls of, 27
swellings of, obstructing labor, 480
tumors of, obstructing labor, 481
vault of, 26
vessels and nerves of, 55
Vaginal Cæsarean section, 771
examination in labor, 245
in placenta prævia, 541
in pregnancy, 160
in puerperium, 641
in rupture of uterus, 532
in transverse presentation, 503
fornices, 26, 27
incision in septic ectopic cases, 409
lacerations, combined external and internal, 680
complete tear, 684
internal, immediate repair of, method of operating, 681
repair of, after-treatment, 683
superficial external, repair of, 679
outlet, injury to, in labor, 678
superficial external tear of, 679
secretions, 625
micro-organisms in, 625
microscopical examination of, 625
signs in multiple pregnancy, 318
Vaginitis, puerperal, 614
Vagino-fixation, influence of, on version, 749
Valve, Eustachian, 96
Valves of Houston, 31
Varices in pregnancy, 426
Varolian bend of embryonic brain, 96
Varolius. *See* Pons Varolii.
Vasculitis, fœtal, 358
Vas deferens, development of, 111
Vasa efferentia, development of, 111
Vein, azygos, development of, 94
iliac and portal, development of, 94
pulmonary, development of, 95
Veins, azygos, 95
cardinal, development of, 94
ductus venosus, 96
effect of, in pregnancy, 125
hemiazygos, 95
hepatic, 95
iliacs, internal, 95
jugular, 94
of Fallopian tubes, 56
of mammary gland, 69

Veins of ovaries, 56
of pelvic floor, 54
of uterus, 55
of vagina, 54
omphalo-mesenteric, 92
portal, 95
pulmonary, 96
sinus venosus, 96
umbilical, 94
vena cava, inferior and superior, 96
vitelline, 93, 96
Ventricle, fourth, development of, 99
third, development of, 98
Ventro-fixation, influence of, upon version, 749
Veratrum viride in eclampsia, 568
Vermiform appendix, 107
Vernix caseosa, 282
Version, 729
artificial, in transverse presentations, 505
bipolar, 732
Braxton Hicks' method, 505
indications for, 732
method in placenta prævia, 547
of performance, 732
cephalic, indications for, 729
complications of, 748
dangers of, 730
effect of ventro-fixation and vagino-fixation on, 749
external, 730
contraindications to, 731
favorable conditions for performance of, 730
for accidental hemorrhage, 550
for placenta prævia, 546
for prolapse of cord, 523
for transverse presentations, 505
in rupture of uterus, 533
indications for, 489, 512, 533
influence of posture in facilitating, 749
internal, 734
advantages of, 735
contraindications to, 735
dangers of, 735
indications for, 734
method of operating, 735
podalic, contraindications to, 729
in placenta prævia, 546
extraction in, 744
indications for, 729
relative value of, 749
uterine rupture from, 530
Vertebræ, injuries to, at birth, 656
Vertebral artery, origin of, 93
Vertex of head, 181
positions, 186
Vesicle of Purkinje, 74
Vesico-uterine ligaments, 63
pouch, anatomy of, 42
-vaginal septum, 29
Vesicular mole, 324
Vessels of pudendum, 20
Vestibule, anatomy of, 21
Viburnum in threatened abortion, 375
Vigier modification of milk, 301
Visceral arches. *See* Branchial arch.
clefts. *See* Branchial clefts.
Vitelline arteries, 93
membrane, 74
veins, 93, 96
Vitellus of ovum, 74
Vitreous humor, development of, 101
Vomiting of pregnancy, 422
induction of abortion in, 426
mild types, 422
pernicious, acute variety, 423
subacute variety, 423
prognosis of, 423
Vulva, anatomy of, 17–26
connivens, 19
development of, 114
hæmatoma of, cause of dystocia, 480
treatment of, 537
hians, 19
labial abscess of, cause of dystocia, 481
œdema of, cause of dystocia, 480
obstructing labor, 480
stenosis of, 480
thrombosis of, 535
tumors of, obstructing labor, 481
varicose veins, cause of dystocia, 480
Vulvar artery, 54
dressing, 257
Vulvo-vaginal glands, 22

W.

Wagner, germinal spot of, 74
Walcher's position in forceps operation, 711
in labor, 247
in version, 740
with contracted pelvis, 450
with flat pelvis, 456
Weaning of child, 273
Weight during pregnancy, 126
loss of, in puerperium, 267
of new-born child, 283
Wet nursing, 291
Wharton's jelly, 87
Whey, preparation of, 292, 302
"White line," anatomy of, 36
Wigand-Martin method of manual extraction, 499
Winckel's disease, 667
Wiring after rupture of symphysis pubis, 535
Wolff, body of, 108
duct of, 108, 110
Wolffian bodies, 108, 110
anatomy of, 44
duct of, 108, 110
tubules of, 110
Wormian bones, 181

Y.

Yolk of ovum, 74

Z.

Zona pellucida of ovum, 74
radiata, 74

Museum
RG
524
.J62

293651

Jewett, Charles

The practice of obstetrics by American authors.